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 Subject: CPUC White Paper on Electric Distribution Security
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I am sending this as FYI only.

I stumbled on this paper this afternoon "Security and Resilience for California Electric Distribution Infrastructure: Regulatory and Industry Response to Senate Bill (SB) 699". It was published by the California Public Utilities Commission (CPUC) in January 2018 (this month) in response to a 2014 directive from the state legislature.

Purpose:

"Following the Metcalf incident, California lawmakers passed new legislation, SB 699¹ (Hill, 2014), that directed the California Public Utilities Commission to explore policies and practices related to physical security of electric distribution assets. Specifically, the law directed the Commission to consider adoption of new standards and rules to address any physical security risk to the distribution system of California's electric corporations so as to ensure "high-quality, safe, and reliable service.""

"This Staff White Paper report provides background material developed in support of the CPUC's response to SB 699, carried out within the Rulemaking proceeding R.15-06-009.² CPUC staff at the Safety and Enforcement Division's Risk Assessment and Safety Advisory section conducted a series of workshops to gather expert opinion and aid understanding of security practices in place at the federal level. This public engagement effort informed the proceeding about potential practices and policies that might apply to state-jurisdictional entities."

Recommendations:

- "The informal Utility Physical Security Working Group formed for this proceeding (and which formulated the Joint Utility Proposal) should continue to convene and be encouraged to engage with the Commission and its staff.
- The CPUC Safety & Enforcement Division (SED) should forge stronger ties and rapport with key physical security partners with participation by the utilities and their working group.
- Actors responsible for California's electric grid physical security should share resources and data to improve monitoring of operations that span utility territories.

Andy's NOTE: From reading the report, "actors" means utility operational and security personnel as well as state/federal entities.

- California utilities, through the working group, should consider the value of, and report back to the Commission with an opinion on, available tools such as the

Environment for Analysis of Geo-Located Energy Information (EAGLE-I) managed by the U.S. DOE, which inputs data directly from energy sector partners, performs big data analysis, and shares situational awareness data.

- California utilities should consider the value of, and report back to the Commission with an opinion on, U.S. DOE's new information classification system, "Critical Electric Infrastructure Information" (CEII) that facilitates voluntary sharing of critical electric infrastructure information between federal, state, and local government, and utilities.
- California electric utilities' regular planning and preparation for major outage incidents should incorporate physical security strategies.
- California electric utilities should be proactive to incorporate the latest modeling and quantitative risk analysis tools, methodologies, and expertise to record, categorize, and trend incidents to more thoroughly expose threats to the electric grid.
- California electric utilities should offer an opinion to the Commission on whether the U.S. DHS Security Regional Resiliency Assessment Program could have value in protecting California's distribution systems.

Andy's Note: This is the DHS program that was discussed during the MISO Security Group Webinar in October 2017.

<https://www.dhs.gov/sites/default/files/publications/rrap-fact-sheet-2015-508.pdf>

- To ensure more consistent physical security initiatives among the utilities, their security and response teams should identify those best practices which provide actionable steps for utilities to avert and respond to outage incidents.
- California electric corporations should form alliances to provide mutual aid and sharing of response resources when one or more members is in need of assistance due to an emergency incident.
- California electric utilities should be mindful of opportunities for grid architecture improvements when considering new security and resilience measures. There should be an emphasis on incorporating a menu of physical security strategies any substation from the time of its inception, including outright hardening of facilities, Protection in Depth (PID), and Crime Prevention Through Environmental Design (CPTED).
- When rebuilding, in response to an outage, utilities should embrace opportunities that often exist for improvements to the electric grid that go beyond mere in-kind replacement of prior infrastructure."

The report also states: "The Commission is considering a specific Joint Utility Proposal to establish individual Distribution Substation and Distribution Control Center Security Programs (Distribution Security Program). The joint proposal is focused largely on a process for utilities to assess their distribution systems -- primarily substations -- in terms of vulnerability to physical attack and ability to reduce adverse impacts. That proposal will be the subject of a separate SED Staff evaluation and proposal."

To me, the report appears critical of the progress and reporting transparency made by Pacific

Gas & Electric (PGE) and San Diego Gas & Electric (SDGE) – pages 52-57. The CPUC also appears to be critical of the culture and working relationships between the stereotypical utility “operations” staff and the utility security staff and the information sharing with the CPUC – page 58.

“IOU physical security efforts, staffing, and expertise appear to rely in large part on veterans of the military and law enforcement. While these expert backgrounds provide valuable rigor and standardization to physical security efforts, at times the tightlipped security culture they bring to the hinders the Commission’s efforts to ensure transparency. Uneven rapport and uneven resources put toward rapport building among the physical security staff at the three IOUs with SED was evident in in 2017 in the course of carrying out routine regulatory oversight functions. The culture difference that exists between regulatory and martial professions that is now being felt within the halls of the utilities and the Commission will need to be bridged and crossed to facilitate appropriate oversight of the physical (and cyber) security activities of jurisdictional utilities. SED staff encourage the IOUs to provide a signal of their commitment to reform disclosure and information sharing.”

“In addition, SED staff have witnessed varying degrees of preparedness, cooperation, and openness in interactions with IOU staff overseeing threat and security efforts. There remain issues with IOU staff turnover, evidence of disorganization when there is a handoff of roles and responsibilities to newly assigned IOU staff, and when the left and right hands of a utility organization function seemingly without knowledge of the other’s actions. Given the sizable expenditures put toward physical security as described above, there is an obligation for the utilities to better demonstrate and convey how these monies are being appropriately programmed, how grid assets are being adequately protected, and how risk is being managed in a responsible and optimal manner.”

Andy

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Safety and Enforcement Division

Security and Resilience for California Electric Distribution Infrastructure: Regulatory and Industry Response to SB 699

A CPUC Staff White Paper

January 2018



**California Public Utilities Commission
Safety and Enforcement Division
Risk Assessment and Safety Advisory Section**

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SED staff would like to thank the many interested and engaged stakeholders who contributed to the physical security proceeding and the public participation process. These parties include the California Office of Emergency Services (Cal-OES), such Federal agencies as the Department of Homeland Security (DHS), the North American Electric Reliability Corporation (NERC), and the Federal Bureau of Investigation (FBI).

This work benefitted greatly from input by members of a technical working group that involved the investor- and publicly-owned electric utilities. Valuable information also came from trade associations, including the Edison Electric Institute (EEI), the National Rural Electric Cooperative Association (NRECA), the California Municipal Utilities Association (CMUA), and the Northern California Power Agency (NCPA), as well as electric professional societies which include the Institute for Electric and Electronic Engineers (IEEE).

Deserving special mention and thanks is the audit and compliance staff at the Western Electricity Coordinating Council (WECC), who – as enforcement regulators for transmission assets under NERC CIP -- on several occasions shared expertise with SED staff. From these interviews, SED staff knowledge and understanding benefitted from WECC's deep experience with the validation and implementation of electric utilities' physical security plans. WECC staff's verification of assumptions and service as a sounding board for ideas was invaluable as California sought to apply security requirements to its distribution assets.

Disclaimer

This Report was prepared by California Public Utilities Commission (CPUC) staff. It does not necessarily represent the views of the CPUC, its Commissioners, or the State of California.

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This Report has not been approved or disapproved by the CPUC.

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Physical Security R.15-06-009

1 EXECUTIVE SUMMARY

The April 2013 sniper attack on Pacific Gas and Electric's Metcalf substation has been described variously as a "wake-up call" or an alarm for the electric utility industry to apply closer scrutiny to the vulnerability of key infrastructure to various kinds of attack – whether physical, as in the Metcalf shooting, or in the form of cyber attacks that might impair physical operations.

For the electric grid, this has led to calls to guard against potential attacks on not only high-profile, Federally-regulated assets, but also facilities traditionally left to state-level purview, such as distribution assets. Efforts to ensure the security of key generating facilities along with critical infrastructure at the high-voltage transmission level have been ongoing for about the past 15 years, there is a lingering concern that the distribution grid might also be vulnerable to physical attack.

Following the Metcalf incident, California lawmakers passed new legislation, SB 699¹ (Hill, 2014), that directed the California Public Utilities Commission to explore policies and practices related to physical security of electric distribution assets. Specifically, the law directed the Commission to consider adoption of new standards and rules to address any physical security risk to the distribution system of California's electric corporations so as to ensure "high-quality, safe, and reliable service."

This Staff White Paper report provides background material developed in support of the CPUC's response to SB 699, carried out within the Rulemaking proceeding R.15-06-009.² CPUC staff at the Safety and Enforcement Division's Risk Assessment and Safety Advisory section conducted a series of workshops to gather expert opinion and aid understanding of security practices in place at the federal level. This public engagement effort informed the proceeding about potential practices and policies that might apply to state-jurisdictional entities.

¹ Public Utilities Code Section 364 (*Amended by Stats. 2015, Ch. 612, Sec. 10. Effective January 1, 2016*). Available for download at: http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB699

² CPUC, Order Instituting Rulemaking Regarding Policies, Procedures and Rules for Regulation of Physical Security for the Electric Supply Facilities of Electric Corporations, June 2015. Available for download at docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M173/K203/173203646.PDF

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The three major issue areas addressed in this proceeding are 1) identifying a process for the prioritization of strategic electrical facilities and determining appropriate security measures or approaches to ensuring resiliency of the system, 2) establishing practices for the exchange of highly-confidential or “sensitive” information between utilities and the Commission, and 3) confirming whether existing incident reporting requirements are adequate. These three subject areas are examined with an eye toward ensuring appropriate regulatory oversight of jurisdictional utility operational performance, and providing a mechanism for entities not subject to CPUC ratemaking authority to identify their own most appropriate measures.

With the experience electric utilities have gained in complying with relatively new Federal standards for critical infrastructure protection, California’s electric system operators have already identified the most critical assets subject to potential attack, and have taken steps to increase security via “hardening” of select critical infrastructure, especially substation facilities, as well as additional security measures, such as video surveillance, alarms and patrols. Already, California’s jurisdictional utilities (aka Investor Owned Utilities or “IOUs”) have sought approval for tens of millions of dollars in General Rate Case funding to ensure physical security.

On the issue of physical security, it has become clear that there exists a clear distinction between those issues that apply to distribution assets versus more critical assets on the high-voltage transmission networks. Even a coordinated attack against distribution facilities is unlikely to result in widespread system disturbances or cascading outages, owing to the local grid’s built-in redundancy and the relatively small service share typically assigned to any single distribution substation. Depending on the design of the distribution system, redundancy can be built into system such that disruptions can be limited and an affected distribution circuit can be served by an alternative substation.

Reasonable security measures for utility distribution assets are not predicated on how well defended these assets may be. Rather, there should be a balance between preventive measures addressing infrastructure and security improvements, and ensuring the resiliency of the distribution network. Thus, effective risk mitigation could be made to address both the likelihood of an adverse event, *and* reduce the potential consequences of an incident.

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Additionally, despite an emphasis on averting planned physical attacks, such as the Metcalf shooting, the vast majority of so-called physical security incidents on the distribution system have consisted of minor property crimes such as vandalism, copper theft, and trespassing. These crimes are generally committed not by determined or organized attackers, but by opportunists. Appreciating this distinction will lead to more effective approaches at a more reasonable cost than would a “one size fits all” strategy of attempting to “harden” all facilities as if they were critical assets.

Eventually, for CPUC jurisdictional utilities, the costs of such preventive measures – whether in the form of “hardening” assets against attack, or ensuring that any disruptions to service are minimized by bolstering the resiliency of the system – would be accounted for in General Rate Case applications. Such costs would be separate from and additional to those incurred to meet Federal requirements for protecting critical infrastructure.

California electric IOUs appear to be well ahead of many of their peer organizations in North America and are serving as physical security innovators within the electric industry. Driven in part by NERC CIP-014 regulations, California IOUs are upgrading security operations centers and are “hardening” select transmission facilities (incorporating security upgrades that include perimeter fencing, electronic monitoring equipment, and improved access control). The IOUs are also continually testing new equipment to assess potential and cost-to-benefit tradeoff. Still, while California IOUs have demonstrated they are well ahead of many of their peer utilities, they have yet to attain their full physical security potential and competency. Similarly, the IOUs will need to continue to build their capacity in this area to assure they are well positioned to respond to an ever-shifting risk landscape.

This report concludes with recommendations for activities that would support a more robust program for assessing and bolstering both the physical security of key distribution assets and the resiliency of the distribution networks. Chief among these recommendations is that California’s electric utilities – both investor-owned and publicly-owned – should assess their distribution assets and develop risk-based physical security plans. Specific staff recommendations on a Joint Utility Proposal raised in the R.15-06-009 rulemaking will be

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reserved for the formal docket. This report, however, offers other ideas that may guide utility efforts to improving infrastructure security and cooperative policies.

1.1 RECOMMENDATIONS

- The informal Utility Physical Security Working Group formed for this proceeding (and which formulated the Joint Utility Proposal) should continue to convene and be encouraged to engage with the Commission and its staff.
- SED should forge stronger ties and rapport with key physical security partners with participation by the utilities and their working group.
- Actors responsible for California's electric grid physical security should share resources and data to improve monitoring of operations that span utility territories.
- California utilities, through the working group, should consider the value of, and report back to the Commission with an opinion on, available tools such as the Environment for Analysis of Geo-Located Energy Information (EAGLE-I) managed by the U.S. DOE, which inputs data directly from energy sector partners, performs big data analysis, and shares situational awareness data.
- California utilities should consider the value of, and report back to the Commission with an opinion on, U.S. DOE's new information classification system, "Critical Electric Infrastructure Information" (CEII) that facilitates voluntary sharing of critical electric infrastructure information between federal, state, and local government, and utilities.
- California electric utilities' regular planning and preparation for major outage incidents should incorporate physical security strategies.
- California electric utilities should be proactive to incorporate the latest modeling and quantitative risk analysis tools, methodologies, and expertise to record, categorize, and trend incidents to more thoroughly expose threats to the electric grid.
- California electric utilities should offer an opinion to the Commission on whether the U.S. DHS Security Regional Resiliency Assessment Program could have value in protecting California's distribution systems.

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- To ensure more consistent physical security initiatives among the utilities, their security and response teams should identify those best practices which provide actionable steps for utilities to avert and respond to outage incidents.
- California electric corporations should form alliances to provide mutual aid and sharing of response resources when one or more members is in need of assistance due to an emergency incident.
- California electric utilities should be mindful of opportunities for grid architecture improvements when considering new security and resilience measures. There should be an emphasis on incorporating a menu of physical security strategies any substation from the time of its inception, including outright hardening of facilities, Protection in Depth (PID), and Crime Prevention Through Environmental Design (CPTED).
- When rebuilding, in response to an outage, utilities should embrace opportunities that often exist for improvements to the electric grid that go beyond mere in-kind replacement of prior infrastructure.

The Commission is considering a specific Joint Utility Proposal to establish individual Distribution Substation and Distribution Control Center Security Programs (Distribution Security Program). The joint proposal is focused largely on a process for utilities to assess their distribution systems -- primarily substations -- in terms of vulnerability to physical attack and ability to reduce adverse impacts. That proposal will be the subject of a separate SED Staff evaluation and proposal.

2 INTRODUCTION

The 2013 sniper attack on PG&E's Metcalf electric transmission substation south of San Jose³ resulted in waves of concern felt from the halls of Sacramento to Washington, D.C. The incident sparked calls for tougher regulations to improve electric grid security standards, accountability, and transparency. The response at the Federal level came first, leading to additional provisions for Critical Infrastructure Protocols (CIP) that had been in effect for a decade. These were developed in a sweeping rulemaking by the Federal Energy Regulatory Commission (FERC).⁴

Specifically, FERC directed the North American Electric Reliability Corporation (NERC) to establish criteria for determining assets to be subject to CIP rules – which cover a gamut of security areas, including physical- and cyber security – resulting in new rules that bind electric utilities to employ physical security plans as a means to address vulnerabilities. The new NERC CIP requirements, CIP-014, apply to any asset deemed not redundant and for which, if failure occurred, cascading power failures could result. For electric substations regulated by FERC, this corresponds to applicable *transmission* substations.

California State lawmakers' 2014 response to the Metcalf incident took the form of SB 699 (2014 – Hill)⁵ and centered on perceived gaps in CIP-014 that could potentially render *distribution* facilities vulnerable. In amending existing emergency reporting statutes, SB 699 directed the Commission to identify and address as appropriate any existent NERC CIP *potential vulnerability gap*, so as to provide assurance of adequate security safeguards for electric distribution systems.

³ The April 16, 2013, late-night incident in which approximately 100 rounds of high-caliber rifle ammunition were fired at a PG&E transmission substation raised national awareness of the vulnerabilities of the electric infrastructure by physical attack. The perpetrators were not apprehended and remain at large. A sizable reward for information has been offered.

⁴ The Energy Policy Act of 2005 (Energy Policy Act) gave FERC the authority to oversee the reliability of the bulk power system, including authority to approve mandatory cybersecurity reliability standards. NERC) which FERC certified as the nation's Electric Reliability Organization, developed Critical Infrastructure Protection (CIP) cyber security reliability standards. On January 18, 2008, the Commission issued Order No. 706, the Final Rule approving the CIP reliability standards, while concurrently directing NERC to develop significant modifications addressing specific concerns.

⁵ Public Utilities Code Section 364 (*Amended by Stats. 2015, Ch. 612, Sec. 10. Effective January 1, 2016*).

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The law further directed the Commission to consider adoption of new standards and rules to address any physical security risk to the distribution system of California’s electric corporations so as to ensure continuous high-quality, safe, and reliable service. It also extended the Commission’s enforcement authority over any utility non-compliance.

2.1 COMMISSION RESPONSE TO LEGISLATURE’S DIRECTIVE

The resulting Commission rulemaking (R.15-06-009) was initiated in June 2015, but accelerated in activity in early 2017, following a second pre-hearing conference and a scoping memo to frame the effort’s objectives. SED staff conducted extensive research and outreach including conducting four public workshops around the state, interviews with experts in grid security, and tours of utility distribution facilities and control centers. These efforts better enabled staff to build a record, gain broader understanding of federal policy and California utility practices, and learn and hear from stakeholders and experts.

The proceeding has employed a research and workshop process to gather information and insights about the federal regulations and processes governing critical assets under the NERC/FERC program, and to hear from representatives of various agencies involved in electric physical security efforts – ranging from the Department of Homeland Security to the Federal Bureau of Investigation, and from the Western Electricity Coordinating Council to California’s network of “fusion centers” that serve as information hubs for critical infrastructure.

The primary three issue areas addressed in this proceeding are 1) identifying a process for the prioritization of strategic electric facilities and determining appropriate security measures or approaches to ensuring resiliency of the system, 2) establishing practices for the exchange of highly-confidential or “sensitive” information between utilities and the Commission, and 3) confirming whether existing incident reporting requirements are adequate. These three subject areas are examined with an eye toward ensuring appropriate regulatory oversight of jurisdictional utility operational performance, and providing a mechanism for entities not subject to CPUC ratemaking authority to identify their own most appropriate measures.

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Working in cooperation, utilities participating in the process – both investor owned utilities and publicly owned utilities and co-operatives – have reached consensus on a Joint Utility Proposal to establish individual Distribution Substation and Distribution Control Center Security Programs (Distribution Security Program). The joint proposal is largely focused on a process for utilities to assess their distribution systems, primarily substations, in terms of vulnerability to physical attacks and ability to reduce adverse impacts. That proposal has been circulated to the Service List of this rulemaking, and will be the subject of a separate SED Staff evaluation and proposal.

This White Paper report will not specifically address the Joint Utility Proposal, as it is subject to Commission consideration and possible refinement in the rulemaking. This report is more concerned with the status of industry efforts to ensure physical security to date, and provides background that that has framed the utility proposal, and that will inform the Commission's future policy determinations. Any recommendations for continued actions by utilities and the Commission presented here do not need to be adopted by the Commission or codified within Commission policy at this time.

2.2 SUMMARY OF STAFF ASSESSMENT OF RISKS SURROUNDING DISTRIBUTION ASSETS

Because of the experience gained as electric utilities have implemented the federal program for critical infrastructure protections, California's electric system operators have already identified their most critical assets for vulnerability, and have taken steps to increase security via "hardening" of (primarily transmission) substation facilities, as well as improvements to security measures, such as video surveillance, alarms and patrols. Already, California's jurisdictional utilities have sought approval for millions of dollars in General Rate Case funding to ensure physical security and compliance with CIPs.⁶

The next level, determining proper policies and procedures for distribution-level assets, needs to be understood in the proper context. Even a coordinated attack against distribution facilities

⁶ A separate and much larger amount of funding for utility physical security efforts is linked to Federal compliance efforts authorized by FERC rates.

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is unlikely to result in widespread system disturbances or cascading outages, owing to the local grid's built-in redundancy and the relatively small service share typically assigned to any single distribution substation.⁷ Depending on the design of the distribution system, redundancy can be built into system so that a distribution circuit can be served by an alternative substation if the primary substation experiences an outage.

Sound security practices for utility distribution assets are not predicated on how well defended these assets may be. Rather, there should be a balance between infrastructure and security improvements – preventive measures – and ensuring the resiliency of the distribution network.

Thus, effective risk mitigation could be made to address both the likelihood of an adverse event, such as a Metcalf-like attack, *and* reduce the potential consequences of an incident. This approach is valuable, not just for addressing physical security, but also for reducing impacts from weather events as well as the notorious catch-all “other” category-of-causes of system disturbances.⁸

The nature of these facilities individually, as comparatively expendable, and the high cost that would accompany any comprehensive attempt to fortify them to a level that would render them impermeable, makes the prospect of categorically “hardening” these assets impractical and cost prohibitive.⁹

California's existing IOU distribution substations generally exhibit multiple characteristics that render them low-value targets that would be prohibitive to categorically defend or harden.

⁷ Substation density ranges from one per 100 square miles in PG&E service territory to one per 270 square miles in SCE service territory. A PG&E distribution substation serves an average of 7,600 customers per substation; a SCE distribution substation serves an average of 82,000 customers per substation. Distribution substations range from a small rural substation with a nominal rating of 5 megavolt ampere (MVA), to an urban station may be over 200 MVA.

⁸ For example, in 2015, a squirrel came into contact with substation equipment and caused a two-hour-long outage incident that impacted 45,000 customers from Richmond to Berkeley.

⁹ Additionally, staff opinion holds that even if a distribution substation were to be fortified as a walled fortress facility, their assets would still be vulnerable to a determined attacker. Additional significant costs on-site security guards would likely be necessary to deter intrusions or attacks. Even armed guards would not be able to defend against a military-grade coordinated attack.

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These include:

- Voluminous (a number exceeding 300, counting IOUs alone);
- Moderately to highly redundant;
- Relatively dense in their siting and typically spaced within of a few miles of one another;
- Located within urban areas of moderate to high density;
- Compact in footprint area, typically consuming no more than one-quarter to one acre;
- Able to be repaired fairly quickly (typically within a week or less); and
- Difficult to defend against a well-prepared and determined attacker.

These characteristics argue against attempting to employ a “one size fits all” strategy for physical security. Instead, the best approach would appear to be one that affords some flexibility while stressing the value and importance of: 1) assessing facilities for their contribution to system reliability and nature of load served, 2) evaluating their vulnerabilities to intrusion, attack or other disturbances, and 3) ensuring redundancy in the local system in the event of an adverse incident.

In this report SED staff offers a list of recommended strategies and proposed new utility practices as practical and low-cost reforms that help make the grid more secure without unduly raising consumers’ electric bills.

3 ELECTRIC UTILITY PHYSICAL SECURITY IN THE POST-METCALF ERA

3.1 ROLE OF DISTRIBUTION SUBSTATIONS AND TYPICAL FACILITY DESCRIPTION

In many regards, distribution substations are the motherboards of the electric grid, effectively providing the path of flow for energy along pre-determined networks circuitry. Distribution substations have the important role of converting and lowering primary voltages from the transmission system -- which in California can range from primary voltages from 69 kilovolt (kV) to 500 kV -- to secondary voltages on the distribution system, ranging from 2.4 to 34.5kV.

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California's combined count of electric transmission and distribution substations exceeds 3,200 across its several dozen electric utilities, whether investor- or publicly-owned entities. SED staff estimates the total distribution substation number at about 2,000.¹⁰

The California distribution systems were built in the period from the late 1940s to the 1970s, when the population grew from 7 million in 1940, to 22 million in 1975. The electric grid followed the population's migration to the suburbs and beyond, with distribution substations serving as the critical link from primary to secondary service; from the transmission line to the customer meter.

During this period -- 1946 to 1953 -- Pacific Gas and Electric invested over \$1 billion in new system facilities, representing the most rapid large-scale utility expansion ever for a U.S. energy utility.^{11, 12} During this period, California electric utilities built thousands of miles of electric line extensions and associated distribution substations.

These legacy substations and their hardware have not changed much since construction, and the era in which they were built was little, if at all, concerned with potential terrorist attacks. Facilities were (and in many cases, still are) often fully visible to the public, often located close to voltage load centers, and without much of a protective barrier apart from chain link fencing and perhaps barbed wire.

3.2 TYPICAL DISTRIBUTION SUBSTATION DESCRIPTION

A typical distribution substation is relatively compact, with an area of less than one acre in urban areas to a few acres in rural locations, and is enclosed by 6-to 8-foot-high chain-link fencing. In dense urban areas such as San Francisco or downtown L.A., a substation may be enclosed within a building shell. In residential or commercial areas, substations they are usually screened to make them less conspicuous. Tall landscaping acts as a visual barrier, obscuring

¹⁰ Data request responses by the three major investor-owned utilities put the count of distribution substations at 1,500. The 2,000 count would include those owned by POUs (municipal electric utilities).

¹¹ 1950s dollars, equivalent to over \$10 billion in 2017 dollars assuming annual inflation rate of 3.53 percent.

¹² Coleman, Charles, *PG and E of California, The Centennial Story of Pacific Gas and Electric Company 1852-1952*, McGraw-Hill, 1952.

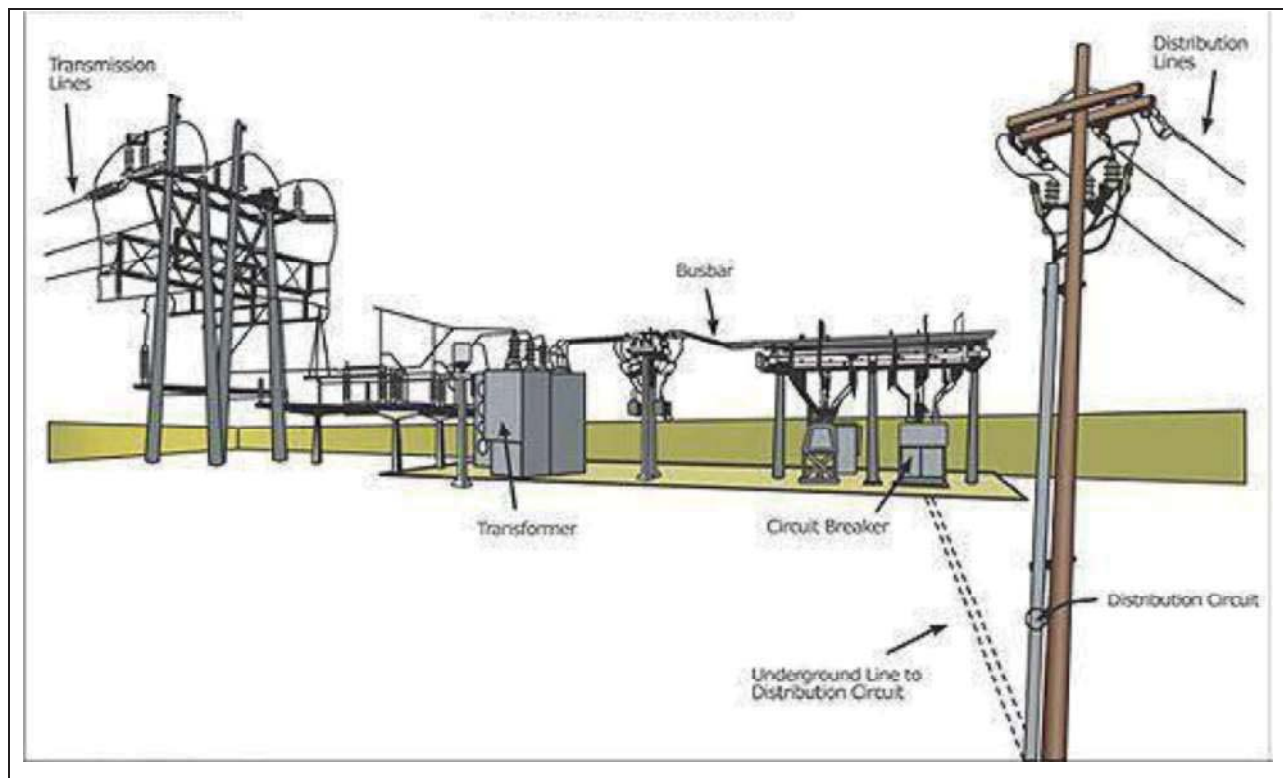
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assets from public view, but offering screening to intruders. In the case of adjacent mature trees, high branches and limbs may serve as a ladder into the facility.

In urban areas, it is not uncommon that a substation is sited adjacent to a neighboring residential or commercial use. For urban substations, razor wire is frequently applied atop fencing as an extra security measure. A facility in a rural setting would typically be isolated, creating a different set of issues surrounding security and incident response.

The volume of distribution equipment and complexity of hardware at substation facilities vary, but they are generally sized and built to meet the existing and anticipated electric service needs of the nearby community. Although size and load capacity will vary from facility to facility, substations largely share consistency of design and configuration. Most substations feature similar equipment, switchgear, circuit breakers, transformers, and communication and control systems designed to operate safely and seamlessly in providing electric service.

Figure 1. Distribution substation component hardware



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Inside the substation, one will often find a control building containing control panels and other equipment used to operate the substation. These structures are often fortified to thwart entry. At least two transmission lines feed the substation, most often from overhead lines.

The other item that immediately catches one's eye are the transformers – the workhorses of the distribution system – which typically stand over eight feet in height. Substations in more densely-developed areas will have multiple transformers to enable greater operational capacity, flexibility, and resilience. In rural areas a substation may have just a single large three-phase oil-cooled transformer mounted on a concrete pad that rises from a dirt floor. Transformers at distribution facilities (and at transmission substations) are encased in heavy-gauge steel, rendering them resistant to tampering or attack. It is their external radiators that present a vulnerability.

3.2.1 COMMON SECURITY AND THREAT ISSUES SURROUNDING DISTRIBUTION SUBSTATIONS

Common-sense, low-cost solutions appear to hold great potential for increasing the security of these facilities. Particularly in remote areas, substations are often secured with a chain and padlock, as they have been since being constructed decades ago. During one SED staff visit to a distribution substation in the Central Valley, utility staff told of a security incident triggered when a contractor working late one night at a substation neglected to close and lock the gate. Later that night an intruder entered the substation. Fortunately, utility staff were still working on site, and were able to promptly notify law enforcement.

At another utility, a former employee did not surrender his utility keys upon termination, which enabled a physical security incident. The disgruntled former employee entered a substation one night and set fire to a transformer and control building, causing damage that exceeded \$1 million. As a result, the utility since has adopted “smart lock and key” procedures.

At a Southern California substation visited by SED staff, sections of chain-link fencing cut to force entry to the property were evident. The utility had placed temporary patches over these sections of fence. Along this side of the facility, the substation shared a property line with a

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heavily-vegetated parcel that had a flood-control swale and dirt path, which facilitated vandals' access to the utility property without being detected.

Although substations in urban areas are often targets of vandalism and trespassing, given the typical low impact of these threats to distribution reliability, existing security measures may be minimal. This contrasts greatly with what may be found at a larger scale facility that has been determined to be critical for system reliability.

3.3 HARDENED FACILITY EXAMPLE

3.3.1 ELECTRIC TRANSMISSION SUBSTATION, HYPOTHETICAL EXAMPLE

The following "hardened" facility description of an electric transmission substation site, drawn from multiple SED staff site visits to utility substations in 2017, is a composite and is provided here for illustrative purposes as an example of what might be considered the state of the art in measures for protection for such facilities. The example here is provided without regard for cost, which may be extensive or prohibitive.

After driving to the edge of a non-descript, low-density exurb, the vehicle turns off the main arterial and on to an unsigned two-lane road that quickly drops behind rolling hills. After perhaps a quarter mile, passage is blocked by a heavy-duty swivel-arm vehicle gate extending across the road. The gate, of the type frequently employed by the U.S. Forest Service on restricted access roads, is secured by padlock and intended to limit access by cars and trucks. It is here that a utility property notice is posted. The road appears open to pedestrians and bicyclists.

The area immediately surrounding is arid, dusty, and what limited vegetation exists appears as primarily scrub brush and chaparral. No tall or dense groves of trees obscure visibility to the facility. Just outside, there is a parking area, past a chain-link swing-open gate.

Outside the facility, overhead transmission lines are strung along a parade of steel towers converge from several different directions, with larger towers bringing in electrical energy from the regional grid to the substation.

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The facility is protected by a large 10-foot-high prefabricated reinforced panel or cinderblock wall. The wall has a single point of ingress/egress, which is defined by a solid reinforced (approx. 4,000 lb.) rolling door that when opened, retracts into the facility so as to be flush with the wall. The door, so heavy it requires a dedicated 220-watt power line to power its large motor, is capable of withstanding most any ramming attempt by a typical speeding passenger vehicle.

The transmission substation site is perhaps 20 acres in area with the outside grounds covered by a porous, small-rock material. The site is composed of distinct areas; the site covers a lot of area and its limited contents are spaced far apart. At one side far from the gate are simple and compact windowless one-story structures containing office work areas, office equipment, and manual control equipment. Other similar clusters of structures for training, research and demonstration testing, and other utility business lines may be present within various areas on the margins of the site.

At yet another edge of the facility is a large, 40-foot-high, perhaps 50,000-square-foot warehouse building that resembles an airplane hangar. It contains sensitive hardware – inert gas-cooled transformers that require more constant temperature control and protection from the elements.¹³ Such hardware, if unenclosed, would be highly-vulnerable and attractive to would-be attackers.

Between the hangar-like structure and the high, defensive perimeter wall is a tall rack of electronic devices consisting of seven columns of protective switches (used for isolating the transformers from the outside circuit to allow for offline maintenance). This general grade of rack is found elsewhere within the site perhaps three or four times.

In the center of the site are the facility's most vulnerable and costly assets – the transmission transformers – located in the open air. They number perhaps ten in number, have conspicuous multiple fans to aid their oil-cooled external radiators, and each consumes an area on par with a good-sized house.

¹³ This gas is relatively rare and requires a special license to obtain and operate. This SF6 gas, if released into the atmosphere would degrade the ozone layer, similar to consumer-level CFCs.

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Linking the various assets are connected trenches and vaults covered with metal grating. Their perimeter ropes appear to form designated walking paths. In fact, the ropes are intended to keep personnel off the grating areas, which are reserved for making repairs and for catchment of spilled or leaked cooling oil.

Not uncommon for transmission substation sites at the edge of urban areas, this facility has adjacent to it a vast utility stockyard of perhaps four acres. The stockyard, consisting of sheds storing tools and spare parts, contains bulky hardware and materials stored in the open air. The stockyard shares one wall with the substation; its remaining edges are defined by 10-foot-high chain-link fencing.

Outside the wall, a defensive inner-ring buffer zone twenty to fifty yards deep is defined by a 10-foot-high chain-link fence, topped with razor or barbed wire, encircling the immediate outside grounds. It is within this inner-ring buffer that, ideally, any telecommunication vaults or other critical telecommunication infrastructure servicing the facility and not within the inner wall would be sited. Terrain both within and outside the inner-ring buffer zone is cleared of vegetation and other features that could serve to conceal a threat. Additional primary protective raised barriers in the immediate site area may include man-made earthen berms. Remaining utility-owned acreage surrounding the facility but outside the inner-ring area, serves to create yet an additional buffer area between public space and private property. The immediate surrounding area is well lighted with illumination directed outside the walls and away from assets and onto the inner-ring and outer buffer areas.

From outside the facility, the site appears as a well-guarded and impermeable fortress. Conspicuous warning signs are posted at the gate to the chain-link fence and at regular intervals along the fence. The heavy gate would be reinforced with a heavy padlock or preferably with controlled electronic gate access that monitors and records all entries into the facility.

From the gate and fence, security measures and implements are observable in the vicinity of the wall. These include various cameras (most of which are able to pan, either automatically or

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by remote operation), gunshot and motion detectors, a PA system, and barbed wire and/or dagger-like spikes affixed to the top of the wall.

Unseen would be subterranean vibration or seismic detection sensors in the ground below and outside the wall. Additional internal and external detection capacities might include video recognition and analytics, and an ability to detect and track approaching unmanned aerial vehicles (UAVs or drones).

Depending on surrounding outer topography characteristics and sight vantage into the facility, the substation might also incorporate limited placement of 25-foot-high armor shielding to protect the most vulnerable transformer assets from rifle fire by all but the most high-caliber ammunition.

Electronic keys and locks hardware and protocols outside and within the wall of these hardened facilities are one of their most fundamental security features and incorporate smart keys¹⁴ whose access is restricted and can be rapidly reassigned as situations and authorized personnel shift.

Note that these hardened facilities are typically not occupied after normal business hours. As facilities largely controlled by remote central command operators, they may or may not have a large utility staff presence during work hours depending on regular and intermittent ancillary activities they may host such as training and drills, maintenance, storage, and demonstration technologies.

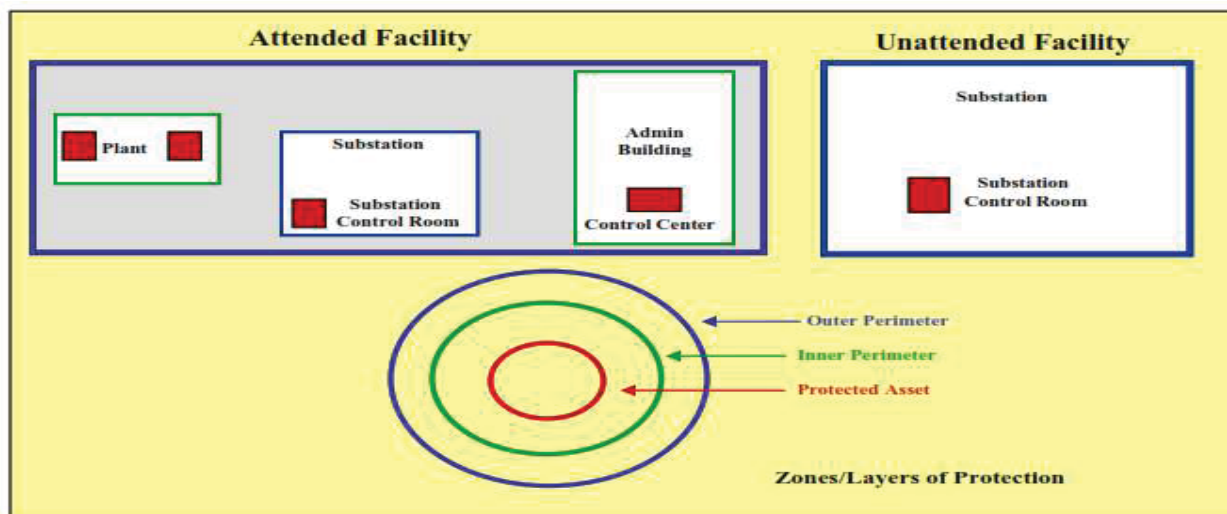
It is clear that this is a thoroughly modernized facility, designated one of California's critical infrastructure assets for its indispensable role as a central hub of the high-voltage network, and afforded a level of protective security measures commensurate with its importance to system reliability.

¹⁴ Generally, such keys can be reassigned and reprogrammed remotely.

3.4 ALTERNATIVES TO FACILITIES HARDENING

Relatively low-cost physical security strategies that rely less on outright hardening and instead attempt to buy response time by slowing an attack's progress, or that aim to deter crime by projecting a sense of a highly-ordered environment, have been gaining traction in recent decades. One, Protection in Depth, or PID, looks to deter, delay, and ultimately frustrate any would-be attacker by situating a facility's most important assets in the center of a series of concentric defensive zones that each must be breached. Such a sequence of barriers, increases the likelihood of, if not outright confounding an attack, at least would allow time for a response.

Figure 2. Diagram of a Protection-in-Depth Placement of Assets



Source: NERC, Electric Physical Security Guideline

NERC sums up PID as “a strategy that seeks to delay rather than prevent the advance of an attacker, buying time by yielding space. Rather than defeating an attacker with a single, strong defensive line, defense in depth relies on the tendency of an attack to lose momentum over a period of time . . .”¹⁵

¹⁵ Security Guideline for the Electricity Sector: Physical Security, NERC, v. 1.9, last revised 2011. Available for download at: <http://www.nerc.com/comm/CIPC/Security%20Guidelines%20DL/Physical%20Security%20Guideline%202012-05-18-Final.pdf>

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A second alternative-to-outright-hardening, “Crime Prevention Through Environmental Design” (CPTED), by contrast, leverages physical orientation and encourages visibility to reduce opportunities for crime and to signal that disorder is not tolerated.

CPTED draws from sociology, architecture, and law enforcement to assess how site conditions and the natural and built environments surrounding a site area may contribute to or deter opportunities for crime. CPTED typically seeks to 1) limit access to a facility by means of a single portal, 2) advance opportunities to see and be seen, and 3) project a strong sense of “territoriality,” ownership, upkeep, and sense of order.

There are researchers¹⁶ who caution that a hazard exists for a corrupting “dark side” of CPTED to emerge when structures are “over-hardened” such that they come to resemble fortresses. Such buildings particularly in urban environments, can have unintended consequences by signaling that the outside world is chaotic to the point of necessitating it be shut out.¹⁷

3.5 KEY PARTNER AGENCIES IN ELECTRIC PHYSICAL SECURITY

The nine entities detailed in **Table 1**, below, play key roles in ensuring the security of the nation’s electric grid. These entities’ contributions include rulemaking, regulatory enforcement, law enforcement and intelligence gathering, and emergency response.

U.S. Department of Energy (DOE)

The U.S. Department of Energy provides support and resources to improve physical- and cyber security and resilience. U.S. DOE’s role includes supporting the Electric Sector Coordinating Council, a public-private partnership that supports threat information sharing, and R&D.

¹⁶ Cozens and Love, Oxford University Press, 2017

¹⁷ These fortress-like structures typically have exterior walls with the first 15 feet of elevation displaying few if any openings. In San Francisco, one striking example would be PG&E’s Embarcadero substation, a fortress-like edifice with a forbidding street presence.

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U.S. DOE is considered to be the nation's most complete source for information on physical security incidents, thanks to its OE-417 Electric Emergency Incident and Disturbance reporting program.

Federal Energy Regulatory Commission (FERC)

FERC is the Federal agency that oversees the interstate transmission of energy in the U.S., including natural gas, oil, and electricity as afforded by the Federal Power Act. Responsibilities include approving reliability standards for bulk power systems to address physical- and cyber security. FERC also certifies Electric Reliability Organizations (EROs, such as WECC, detailed below), which are responsible for the monitoring and enforcement of these standards at the regional interstate level.

North American Electric Reliability Corporation (NERC)

NERC is an NGO that reports to FERC and is responsible for carrying out federal rules surrounding reliability and security of the bulk power transmission system in North America. It oversees eight regional Electric Reliability Organizations that monitor and enforce compliance with NERC/FERC rules. NERC also provides reliability standards for power systems, including the protection of critical infrastructure. NERC has 14 critical infrastructure protection (CIP) standards, 13 of which address cyber security and one standard, CIP-014, to address physical security. NERC operates the Electricity Information Sharing and Analysis Center (E-ISAC) which offers security data services to bulk power system owners and operators.

Western Electricity Coordinating Council (WECC)

The Western Electricity Coordinating Council is an NGO regulatory authority responsible for coordinating and promoting system reliability for the Western Interconnection, a territory that includes 14 U.S. states, two Canadian provinces, and a northern portion of one Mexican state. WECC is the regional compliance enforcement agent for NERC, and to ensure compliance with CIP-014, it conducts audits of utilities' CIP security plans and implementation practices.

WECC supports a *Physical Security Working Group* that meets every six months and consists of about 60 members representing utilities in the Western U.S. The working group exchanges information on physical security best practices including security metrics, active shooter protocols and training, new security technologies, and advanced design. Of particular note, this

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group has provided support to member utilities on CIP 014 compliance, and conveyed Federal updates. The working group also serves liaison between utilities and WECC and the NERC *Critical Infrastructure Protection Committee*.

Governor's Office of Emergency Services (Cal-OES)

The Governor's Office of Emergency Services (Cal-OES) oversees and coordinates emergency preparedness, response, recovery, and homeland-security activities for the State, including the State Threat Assessment Center (STAC), an information clearinghouse directed to strategic threats. Cal-OES administers and disburses over \$1 billion annually in grant monies made available from the U.S. DHS.

U.S. Department of Homeland Security (DHS)

The U.S. Department of Homeland Security provides alerts on active threats, supports state and local efforts to develop strategies, and provides resources to mitigate physical security incidents, including Regional Threat Assessments, security and technical expertise, and grant making. DHS maintains a *National Infrastructure Advisory Council* and a *Critical Infrastructure Partnership Advisory Council* that coordinate infrastructure-protection public-private partnerships.

Federal Bureau of Investigation (FBI)

The Federal Bureau of Investigation investigates suspected terrorist threats and major criminal activities. Physical security incidents that impact the grid are assigned to the FBI's Joint Terrorism Task Force.

Local Law Enforcement

Local law enforcement is typically dispatched to any distribution facility where an event has been reported in order to assess the threat to public safety and determine an appropriate police response. In most cases, local law enforcement must be in communication with the distribution owner to adequately respond to a physical security threat.

Fusion Centers

Fusion centers operate as the State- and major urban center-level for the gathering, analysis, and sharing of threat-related intelligence among Federal, State, local, and industry partners. Fusion centers ensure real-time dispatch of threat information and analysis essential to

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ensuring effective homeland security. They provide interdisciplinary expertise and situational awareness to inform decision-making at all levels of government. They also provide training, technical support, and grant funding. In California, the State Threat Assessment Center (STAC) in Sacramento is the lead for fusion center for State-level threat tracking and serves as California's information sharing clearinghouse of strategic threat analysis and situational awareness reporting. In addition, five regional fusion centers interface with STAC to comprise the State Threat Assessment System.¹⁸

¹⁸ The regional centers are located in Sacramento (Central California Intelligence Center), San Francisco (Northern California Regional Intelligence Center), Los Angeles (Los Angeles Joint Regional Intelligence Center), Orange County (Orange County Intelligence Assessment Center), and San Diego (San Diego Law Enforcement Coordination Center).

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Table 1. Key Physical Security Partner Agencies

Entity Name	Entity Abbreviation or Shorthand	Entity Mission and Purpose	Entity Function within Electric Physical Security	Entity Contribution to Phase I of Proceeding	Public, Private, or NGO	Federal, State, Regional, or Local
U.S. Department of Energy	U.S. DOE	Oversees U.S. coal and nuclear energy and weapons sectors	Oversees all activities associated with the National Infrastructure Protection Plan and Energy Sector Specific Plan	no involvement	Public	Federal
U.S. Department of Homeland Security	U.S. DHS	Multiple federal agencies with roles in protection of homeland security including counterterrorism, cybersecurity, protection of critical infrastructure, and response to major events	Supports State and Regional entities with regional risk assessments and threat & vulnerability assessments	Fusion Center rep spoke at Workshop 1	Public	Federal
Federal Bureau of Investigation	FBI	Law Enforcement	Investigation of physical security incidents that impact interstate commerce or have significant impact on public safety	Staff spoke about agency programs in closed session informing Workshop 1	Public	Federal

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Governor's Office of Emergency Services	Cal-OES	Supports and informs all phases of emergency management including preparedness, response, recovery and mitigation.	Would be brought on in the event of a prolonged significant event to aid recovery and emergency response	Leadership spoke at Workshop 1; provided facility for Workshop 1	Public	State
Local Law Enforcement	County Sheriff or City Police Department	Law Enforcement	Coordinates with and supports utilities in case of physical security event. Provides training for utility physical security and emergency response	no direct involvement, some utility security personnel are former local law enforcement	Public	Local
Intelligence Assessment Centers and Joint Regional Intelligence Centers	Fusion Centers	Law Enforcement	Focal point for the receipt, analysis and sharing of threat-related information among all levels of law enforcement. Six fusion centers located within California	Briefing to SED on Cal COP information platform at the Northern California Regional Intelligence Center	Public	Federal

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North American Electric Reliability Corporation	NERC	not-for-profit organization that develops and enforces Reliability Standards for electric industry	Develops reliability standards regarding critical infrastructure protection for bulk power system in US. Also hosts biennial exercise, GridEx, simulating cyber/physical attack on electric infrastructure.	Presented at Workshop 2 on CIP 014	NGO/quasi-governmental	Interstate, international in scope
Federal Energy Regulatory Commission	FERC	regulates bulk power system, interstate transport of electric power, natural gas, and oil	Statutory authority over physical security of bulk power system with adoption of Physical Security Standard, CIP-014	no direct involvement	Public	Federal
Western Electricity Coordinating Council	WECC	Serves as regional arm for NERC/FERC compliance, enforcement, and promotion of transmission system security within the Western Interconnection	As Electric Reliability Organization, WECC monitors and enforces reliability standards through physical security audits	Presented at Workshop 2 on audit procedures	NGO/quasi-governmental	Regional; interstate, international in scope

3.6 ELECTRIC PHYSICAL SECURITY CONTEXT PRIOR TO 2014

Before the California and Federal responses to the Metcalf incident, electric utility physical security in the United States was voluntary, and largely limited to monitoring physical security incidents. For example, in 2001, the North American Reliability Corporation (NERC) issued its document “An Approach to Action for the Electricity Sector,” which provided guidelines to physical security for electric utilities.¹⁹ The document describes a tiered approach that promoted concepts such as “Defense in Depth” and “Crime Prevention Through Environmental Design,” which are discussed later in this chapter. Similarly, the Institute for Electric and Electronic Engineers (IEEE) in 2000 published its own guidelines, “1402-2000 - IEEE Guide for Electric Power Substation Physical and Electronic Security.”²⁰

Federal-level attention to cyber security intensified after a series of high-profile banking fraud incidents involving organized offshore crime rings that had netted tens of millions of dollars from U.S. financial institutions. Year 2003 was notable for the homeland security-driven “Presidential Directive HSPD-7 for Critical Infrastructure Identification, Prioritization, and Protection,” as well as NERC’s debut of its inaugural cyber security guidelines. Commonly referred to as the NERC Critical Infrastructure Protection (CIP) plan, these information security standards for the electrical power industry came to be known as NERC CSS (Cyber Security Standards).²¹

At around the same time, concerns about the physical security of electrical assets were elevated by a sharp rise in metal theft incidents. The crime increase was attributed to a spike in copper prices that rendered copper wiring more valuable and attractive to would-be thieves. However, copper prices settled back to more traditional cost levels, and since the agency’s last report in the late 2000, the U.S. DOE has been silent on the issue.

In 2010, the National Infrastructure Advisory Council, in conjunction with the U.S. Department of Homeland Security (DHS), issued “A Framework for Establishing Critical Infrastructure

¹⁹ Available for download at <http://www.iwar.org.uk/cip/resources/nerc/cip-nerc.pdf>

²⁰ Available for download at <http://ieeexplore.ieee.org/document/836296/>

²¹ Some iterations later, the version in effect in 2017, is called CIP-002-3 through CIP-009-3, and applies to the bulk power system.

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Resilience Goals.”²² The paper defined *resilience* as the ability to reduce the magnitude and/or duration of disruptive events. The report noted the potential for public agencies to enhance the resilience of the electricity sector, including aligning Federal and State governments in policy, planning, standards and regulations; and improving access to information regarding threats

In February 2013, Presidential Policy Directive 21: Critical Infrastructure Security and Resilience (PPD-21) and Executive Order (EO) 13636, established Federal agencies’ roles regarding physical- and cyber security threats. These policies reemphasized the need for a novel collaborative approach to security and risk assessment, with the U.S. DOE overseeing issues related to the electric utility sector via the newly-formed Electric Subsector Coordinating Council (ESCC).^{23, 24}

3.7 FEDERAL ACTION AND NERC CIP-014

As described above in the Introduction chapter, new NERC physical security standards were adopted in 2014, under CIP-014 for the bulk power system. These rules established a risk-based protocol that identifies critical transmission assets and control centers. In contrast to previous NERC-issued guidelines, CIP-014 authorized FERC to establish one mandatory physical security standard for the nation’s transmission assets.²⁵

To recap, the first security “standard” was developed and issued by the IEEE in 2000. In 2002, NERC issued guidance that provided information on voluntary physical security measures. The

²² Available for download at <https://www.dhs.gov/xlibrary/assets/niac/niac-a-framework-for-establishing-critical-infrastructure-resilience-goals-2010-10-19.pdf>

²³ More at <http://www.electricitysubsector.org/>

²⁴ A Federal-level example of government-utility partnerships, Electricity Subsector Coordinating Council (ESCC) serves as liaison between the federal government and the electric power sector. As a result of the cyber attack on Ukraine’s grid assets in December 2015, the ESCC asked the North American Transmission Forum (NATF), a trade association representing transmission owners, to assess the operating strategies and reliability tools available to the electric power industry should the operations of the bulk electric system be compromised. NATF’s assessment included operating strategies and reliability tools available to operators during such events. Similarly, ESCC, in collaboration with the American Gas Association, developed a “Ransomware Preparedness” document for energy companies that may reduce the risk and associated impacts of ransomware. A separate tool recently co-developed by industry and NERC is the Electricity Information Sharing and Analysis Center (E-ISAC), a secure means of sharing information, improving situational awareness, and communication among all parties during an event.

²⁵ CIP-014 applies to transmission facilities above 500 kV, or those facilities between 200 kV and 499 kV having “aggregated weighted value” greater than 3,000 kV.

Energy Policy Act of 2005, represented the first time the development of utility security standards were mandated, specifying expectation for cyber security protocols. The Federal government then produced a “National Infrastructure Protection Plan,” issued by the DHS in 2006. The plan described how public-private partnerships were to advance the resilience of critical infrastructure community to address security risks. Subsequently, in 2007, FERC issued new regulations under Section 215(d)(1) of the Federal Power Act (FPA), establishing eight Critical Infrastructure Protection (CIP) Reliability Standards.

The CIP Reliability Standards outline criteria that Bulk Power Transmission System utilities must follow to safeguard critical cyber assets. In March 2014, FERC directed NERC to develop a physical security reliability standard for the bulk power system. In November 2014, FERC advanced new regulations within established CIP Reliability Standards for physical security, Reliability Standard CIP-014-1, enforceable by law and subject to penalties for non-compliance. Because CIP-014-1 was issued with an 18-month period allowing for utilities to become compliant, and with somewhat arcane provisions describing a FERC directive to NERC to clarify certain language, CIP-014-2 became effective as the nation’s first physical security standard to govern electric utilities.

The CIP-014-2 standard was made effective by FERC in May 2015, and clarified that only assets with a “critical impact” would be required to conform to the standard, which relies on a complex set of security plan requirements that entail assessing assets and potential threats, outside expertise and peer review, proposed mitigation measures and validation, and site inspections and security plan audit cycles. A complete review of CIP-014 requirements is beyond the scope of this report, but further details about guidelines and requirements are provided in **Appendix 1**.

In the time since CIP-014 became effective, electric utilities have responded by initiating the process with FERC’s designated regional compliance authority or ERO to first determine whether any asset holdings would be subject to CIP requirements. If found to be subject to the rules – wholly based on whether assets are deemed critical – utilities would be advised to initiate the lengthy physical security plan audit process.

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3.7.1 DHS TECHNICAL SERVICES IN SUPPORT OF SECURITY PLANS AND CIP-014

To support bulk-power system owners and operators in their compliance with NERC/FERC CIP-014 standards, DHS offers a *Physical Security Program* (PSP) to facilitate development of security plans for critical infrastructure. The program is voluntary and separate from Federal regulatory activities.

DHS commonly assists electric utilities on a voluntary basis with identification of gaps in infrastructure security. DHS Protective Security Advisors are available to conduct site visits at individual assets to probe existing physical infrastructure, identify vulnerabilities, and locate solutions.

DHS staff reviews of existing procedures and physical security plans -- to offer an independent third-party opinion -- is a second DHS compliance-services offering. Upon completion of such a facility gap analysis, a revised physical security plan can be finalized by the transmission owner or operator for audit and validation by WECC or another ERO.

Table 2 below details DHS offerings to support critical infrastructure security and resiliency, including the agency's Infrastructure Survey Tool, a web-based security survey directed to owners and operators to enable critical infrastructure assessments. With more than 100 questions to gauge security management, information sharing, and protective measures, the survey aids in the identification of vulnerabilities and appropriate mitigation measures.

DHS reports that they are finalizing a means of sharing such vulnerability assessment data with a broader spectrum of stakeholders, which might include Commission staff.²⁶

²⁶ U.S. General Accounting Office, *DHS Risk Assessments Inform Owner and Operator Protection Efforts and Departmental Strategic Planning*, GAO-18-62, October 2017.

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Table 2. Select DHS Risk Information Products and Services

Vulnerability Assessment Actors and Products/Activities	Explanation and Information Sharing Mechanism (if applicable)
National Protection and Programs Directorate - Protective Security Advisors (PSAs)	
Enhanced Critical Infrastructure Protection (ECIP) Visits	PSAs conduct these visits with critical infrastructure (CI) owners and operators to establish DHS's relationship with the facility and communicate available infrastructure protection services that could enhance their security.
Infrastructure Survey Tool (IST)	The IST is a web-based security survey intended to assess a facility's vulnerabilities. Conducted by a PSA in coordination with facility owners and operators, it identifies facilities' physical security, security forces, security management, information sharing, protective measures, and dependencies related to preparedness, mitigation, response, resilience, and recovery.
Rapid Survey Tool	This vulnerability assessment survey is a web-based data collection capability that examines the most critical aspects of a facility's security and resilience posture with baseline questions. The results are analyzed to determine the facility's relative security and resilience in comparison to the national average for similar facilities.
Infrastructure Visualization Platform (IVP)	IVP is a data collection and presentation medium that supports critical infrastructure security, special event planning, and responsive operations. It provides immersive imagery, geospatial, and hypermedia data of critical facilities, surrounding areas, transportation routes, and more. It also integrates assessment data from other PSA assessments.
Regional Resiliency Assessments Program (RRAP)	RRAP is an assessment of critical infrastructure within a designated geographic area and a regional analysis of the surrounding infrastructure to address a range of infrastructure resilience issues that could have regionally and nationally significant consequences.

Source: U.S. General Accounting Office

3.7.2 NERC TECHNICAL SERVICES IN SUPPORT OF SECURITY PLANS AND CIP-014

NERC provides direct support to electric utilities to increase their understanding of the various requirements in CIP-014, and promote transparency and integrity as the industry moves to implement the standard. NERC offers coaching and tutoring on CIP requirements and security plan rigor, on a voluntary and informal basis with utilities to promote robust compliance and partnering. Included in the menu of services are physical security site visits by NERC physical security advisors. NERC officials' presentation at the May 31, 2017, CPUC physical security proceeding workshop described having provided assistance to 19 entities in six U.S. electric grid regions of the US as of August 2016.

Common themes addressed in these collaborations include:

- Timelines for implementing security and resiliency measures
- The role of third-party reviewers and at what stage in the CIP-014 process
- Scope of security plans
- Insider threat concerns
- Confidentiality of information

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In addition, NERC conducts a biennial security exercise, GridEx. First initiated in 2011, the 2017 GridEx IV event simulated a wide-scale physical- and cyber attack on the grid, with over 6,000 participants taking part.

3.8 CALIFORNIA RESPONSE TO METCALF

Almost immediately after the Metcalf incident in April 2013, concerns were raised both in Sacramento and in Washington, DC, about future attacks by lawmakers who feared a repeat of a 9/11-scale homeland threat event.²⁷ For example, the author of SB 699 stated, "The security of our nation's infrastructure is of paramount importance."^{28, 29} Similarly, a former vice president of a major California utility told a utility industry conference in November 2013 that the Metcalf incident was a sinister harbinger of worse to come. "These were not amateurs taking potshots," Mark Johnson, a former vice president for transmission operations at PG&E, warned the grid security conference. "My personal view is that this was a dress rehearsal" for future attacks.³⁰ Some months later and after the trade press broke the story, word of Metcalf and the alarm it was causing, mainstream news outlets got word with some repeating the dire warning with seeming little analysis or filter of skepticism.³¹ As State Senate hearings concluded and facts were gathered, new California legislation began to coalesce on the issue. In 2014, the California Legislature passed and Governor Jerry Brown signed into law SB 699 which amended Section 364 of the Public Utilities Code.

²⁷ The concerns were compounded when it was reported that on August 26, 2014, PG&E reported a break-in at the same facility, with some \$40,000 worth of equipment stolen. SED discovered the thieves had been on-site for over four hours. SED's investigation found gaps in training and security measures.

²⁸ California Senate Rules Committee, [Bill Analysis of SB 699](http://www.leginfo.ca.gov/pub/13-14/bill/sen/sb_0651-0700/sb_699_cfa_20140826_211913_sen_floor.html), 2014. Available for download at: http://www.leginfo.ca.gov/pub/13-14/bill/sen/sb_0651-0700/sb_699_cfa_20140826_211913_sen_floor.html

²⁹ California Senator Jerry Hill August 29, 2014 News [Release](http://sd13.senate.ca.gov/news/2014-08-29-hill-s-bill-heighten-electric-grid-security-sent-governor). Available for download at:

<http://sd13.senate.ca.gov/news/2014-08-29-hill-s-bill-heighten-electric-grid-security-sent-governor>

³⁰ "Military-Style' Raid on California Power Station Spooks U.S.," By Shane Harris, Foreign Policy. December 27, 2013. <http://foreignpolicy.com/2013/12/27/military-style-raid-on-california-power-station-spooks-u-s/>

³¹ "Assault on California Power Station Raises Alarm on Potential for Terrorism. April Sniper Attack Knocked Out Substation, Raises Concern for Country's Power Grid," by Rebecca Smith, *The Wall Street Journal*. February 5, 2014. <https://www.wsj.com/articles/assault-on-california-power-station-raises-alarm-on-potential-for-terrorism-1391570879>

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Similar Federal legislation had been enacted by Congress in 2013, to address grid security at the transmission level. California legislators were able to look to the Federal example and in so doing, identified potential gaps in the new Federal legislation. Specifically, that grid assets subordinate to the transmission level had not been addressed. These distribution assets, which fall outside of Federal jurisdiction, but which are subject to Commission oversight, became a primary focus of the new law.

Public Utilities Code Section 364, as amended by the new law, requires the Commission to adopt standards for distribution facilities that provide for high quality, safe, and reliable service.³² Additionally, Section 364 calls for actions to protect vulnerable electric distribution system assets from deliberate physical threats that could disrupt safe and reliable electric service. The statute also cites the need for appropriate planning in coordination with Federal, state, and local law enforcement authorities to minimize the chance of physical attacks and their potential impacts.³³

Finally, the Legislature authorized the Commission to withhold certain records from the public where such information, if disclosed, would pose a security threat. This provision created for the Commission a new exemption that could be applied to the California Public Records Act requests for public access to documents.³⁴

On June 11, 2015, the Commission issued Order Instituting Rulemaking (OIR) 15-06-009,³⁵ to establish policies, procedures, and rules to address physical security risks to electric distribution facilities. This active physical security proceeding, Phase 1 of the rulemaking, considers whether

³² Pursuant to GOs 95, 128, 131-D, 165 through 167, and 174, Commission staff is routinely involved in the verification of the condition and operation of existing physical security protections. Additionally, D. 14-12-025, which created the utility RAMP (Risk Assessment and Mitigation Phase) process, requires all utilities to discuss safety and risk assessments in every rate case.

³³ Public Utilities Code Section 364, as amended, is expansive and the CPUC is addressing only physical security for electric facilities in this proceeding as a first phase. Section 364 also addresses disruption of essential public services such as safe drinking water, natural gas delivery, emergency response, or medical care.

³⁴ Public Utilities Code Section 364(d): "The Commission may consistent with other provisions of law, withhold from the public information generated or obtained pursuant to this section that it deems would pose a security threat to the public if disclosed."

³⁵ CPUC, Order Instituting Rulemaking Regarding Policies, Procedures and Rules for Regulation of Physical Security for the Electric Supply Facilities of Electric Corporations, June 2015

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new rules, standards, or modifications to existing policies or general orders are necessary to address the physical security risks to electric distributions facilities.

3.8.1 OTHER STATE REGULATORY POLICIES AND PRACTICES SINCE 2014

A 2016 report by the National Council of State Legislators (NCSL) documents the fifty states' efforts in recent years to protect the electric grid.³⁶ It notes that the states are actively addressing threats to the nation's critical infrastructure including physical- and cyber security. Some states have sought to make the grid more resilient by diversifying energy production by such means as introducing microgrids to the distribution system. Several states have also supported smart grid technology which may increase grid resilience.³⁷ This section highlights a few of the more profile efforts of states that appear to show promise for their contributions to growing the existing body of knowledge surrounding state-level efforts to bolster grid security.

3.8.1.1 FLORIDA

An interesting example of state-level inquiry on grid security is the Florida Public Service Commission's 2014 publication, "Review of Physical Security Protection of Utility Substations and Control Centers",³⁸ which provided a comparative assessment of physical security approaches employed across Florida's four major investor-owned electric utilities.³⁹

Findings from this effort include:

- Federal regulations such as NERC CIP requirements and actions by the U.S DHS, U.S. DOE, and other federal agencies have done much to safeguard the most critical bulk power system sector assets;

³⁶ Available for download at http://www.ncsl.org/Portals/1/Documents/energy/ENERGY_SECURITY_REPORT_FINAL_April2016.pdf

³⁷ National Council of State Legislatures, "[State Efforts to Protect the Electric Grid](#)" April 2016

Available for download at http://www.ncsl.org/Portals/1/Documents/energy/ENERGY_SECURITY_REPORT_FINAL_April2016.pdf

³⁸ Available for download at http://www.psc.state.fl.us/Files/PDF/Publications/Reports/General/Electricgas/Physical_Security_2014.pdf

³⁹ The four Florida IOUs are Duke Energy Florida, Florida Power & Light Company, Gulf Power Company, and Tampa Electric Company Florida Public Service Commission, *Review of Physical Security Protection of Utility Substations and Control Centers*, December 2014

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- Extensive efforts and unknown levels of cost accompany utilities' compliance response to NERC reliability standards;
- Selecting and implementing prudent and proportional preparations against physical attack necessitates making value judgments;
- Continuous vigilance and frequent reassessment of risk analysis and threat analysis should be employed by utilities;
- The Florida Public Service Commission (FPSC) and Florida IOUs should work cooperatively to identify appropriate, prudent, and cost-effective levels of protection needed;
- Proposed utility physical security expenditures should be informed by focused risk assessments;
- Because costs must be weighed against potential benefits and perceived risks, utilities would benefit from guidance from the FPSC;
- Efforts by utilities to identify, disclose, and track physical security costs may be necessary, and a focused discussion of such expenditures in company filings and testimony would support appropriate spending.

3.8.1.2 TEXAS

As of 2017, the State of Texas had in progress an initiative to develop a comprehensive physical- and cyber security outreach program for Texas investor- and publicly-owned electric utilities, and cooperatives. Led by the Public Utility Commission of Texas (PUCT), the program is a voluntary promotional campaign that enlists Texas utilities willing to assess corporate culture receptiveness to infrastructure protection efforts and identify areas for improvement.⁴⁰

The objective of the Texas initiative is to:

- Recommend a collaborative framework for information sharing between the PUCT and Texas utilities during times of normal operations and emergency situations;
- Identify, evaluate, and report on existing utility practices for securing critical electric infrastructure and highlight best practices.

To date, although numerous states are actively engaged on electric utility physical security issues, no state-level regulations have yet been enacted.

⁴⁰ Public Utility Commission of Texas, *RFP to Develop A Comprehensive Cybersecurity and Physical Security Outreach Programs for Texas Electric Utilities, Electrical Cooperatives and Municipally Owned Electric Utilities*, March 2017.

3.8.2 OTHER INDUSTRY INITIATIVES

The Edison Electric Institute (EEI), a trade association for investor owned utilities across the nation, EEI promotes an approach to grid security to advance standards, public-private partnerships, and promotes strategies for preparation, prevention, and response.

Since 2014, Institute of Electronic and Electrical Engineers (IEEE) has been developing new guidelines on physical security, P1402 – Guide for Physical Security of Electric Power Substations. Expected to be issued in 2019, IEEE’s guidance would offer recommendations on minimum requirements and practices for the physical security of electric power substations.

4 DISTRIBUTION ASSET SECURITY AND RESILIENCY IN CALIFORNIA

4.1 DISTRIBUTION ASSETS NOT ATTRACTIVE HIGH-VALUE TARGETS

Despite the emphasis on preventing a repeat of a planned physical attack such as the Metcalf shooting, the vast majority of so-called physical security incidents on the distribution system consist of minor property crimes such as vandalism, copper theft, and trespassing. These are committed not by determined or organized attackers, but by opportunists.

In turn, utility supply yards are much more common locations for physical security incidents than distribution substations.⁴¹ This is attributable to utilities’ practice of procuring spare metal, particularly copper, in large bulk quantities to minimize cost. Gigantic copper spools weighing many tons are then typically stored in the open within utility supply yards. Metal thieves are known to trespass and cut out the spool a few pounds of copper, which may render the remaining copper worthless. Such copper spools, often easily visible, appear as more attractive targets for metal thieves than distribution assets, where any available copper would be more scarce, and difficult and dangerous to remove.

⁴¹ It is typical that a supply yard is adjacent to a substation, but may be segregated by a wall or fence. These adjacent substations are typically larger-scale facilities consisting of transmission assets or mixed transmission-generation assets, and might range four to twenty times greater area of a typical residential-scale distribution substation.

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Another insight gleaned from this proceeding is that the electric distribution system in general is not an attractive target for calculated sabotage due to its resiliency and resulting low impact value. In plotting their attacks, saboteurs usually seek publicity to advance their message; a distribution attack and outage would be unlikely to result in impacts that would generate the kind of significant media attention that organized malicious actors would seek.

The electric grid's existing resiliency condition is a result of the distribution system's deliberate redundancy by design. In a hypothetical case, say where a distribution substation transformer were to be targeted by multiple rounds of high-caliber ammunition resulting in a power outage (similar to a 2016 incident in Utah), distribution operators would typically be able to respond by way of remote grid-switching to bypass the affected substation. Meanwhile, the utility's reliability response team would work to rapidly dispatch replacement parts, including entire distribution transformers if needed, located at strategically-sited supply stations to quickly ensure that a facility is repaired and back on line, often within 24 hours.

5 Incident Reporting and Tracking Best Practices

A round-up and comparison of information reporting, tracking, and trending activities among regulatory and industry organizations

5.1.1 COMMISSION-REQUIRED INCIDENT REPORTING

The CPUC has no mechanism in place for electric utilities to specifically report physical security incidents at distribution facilities, and thus lacks a convenient means to track and trend such incidents.

The existing CPUC emergency incident reporting system,⁴² may aid in identifying events that have physical security implications, but there is at present no aggregation of data reported through this system to monitor patterns or trends in physical security at the distribution level. It is also unclear of the level of resources the CPUC puts toward making use of its incident reports.

⁴² Initial Notification Standard, required by GO 167, Section 10.4, specifies that utility incident reports are required to be filed with CPUC for incidents entailing property damage in excess of \$10,000, significant media attention, or a power outage. Available for download here: <http://www.cpuc.ca.gov/General.aspx?id=2721>

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Commission General Order 166 Standard 6⁴³ stipulates that utilities must report within one hour of discovery, any major outage.⁴⁴ The Commission provides a GO 166 incident report summary in its annual report to the Legislature. CPUC Guidelines for electric utility emergency reporting were revised in 2012, and with oversight transferred from Energy Division to what is now the Safety and Enforcement Division (SED).⁴⁵

Incident reports for 2015 and 2016 indicate a low number of physical security related incidents. In 2015, more than 300 incidents were reported to the Commission, with the majority associated with local outages. Only one percent, or three incidents, were linked to a physical security at a distribution asset. In 2016, there were over 150 incidents reported, but none were physical security related. Rather, weather, natural disasters, aging infrastructure, traffic accidents, utility contractors, tree trimming, and mylar balloons accounted for the reports.

5.1.2 U.S. DEPARTMENT OF ENERGY - OE-417 REPORTING

An existing mandatory U.S. DOE reporting system for emergency incidents and disturbances by public and private electric utilities, OE-417 - Electric Emergency Incident and Disturbance Report, appears to perform relatively well. The system is used by NERC to assess physical security trends for the bulk power system. Federal regulatory requirements specify that a Form OE-417 shall be logged by a utility within one hour of discovery of one or more of these qualifying events:

1. **Physical attack** that causes major interruptions or impacts to critical infrastructure facilities or to operations
2. Cyber event that causes interruptions of electrical system operations
3. Complete failure or shutdown of the transmission or distribution system
4. Electric system separation "Islanding"
5. Uncontrolled loss of 300 MW or more of firm load for more than 15 minutes from a single incident

⁴³ General Order 166, available for download here:

<http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M138/K073/138073150.pdf>

⁴⁴ Defined as total loss of power impacting ten percent or more of a utility's customer base. This standard, which pertains to the three large electric investor owned utilities only, would trigger an incident report when there is a simultaneous, non-momentary interruption of service.

⁴⁵ CPUC Memo to rescind all prior versions of the *Guidelines for Notification of the CPUC Energy Division of Emergencies or Urgent Events in Electric Utility Systems*, November 1, 2012. Available for download at: ftp://ftp2.cpuc.ca.gov/PG&E20150130ResponseToA1312012Ruling/2012/11/SB_GT&S_0186388.pdf

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6. Load shed of 100 MW or more implemented under emergency operational policy
7. System-wide voltage reductions of 3 percent or more
8. Public appeals for reduction in electrical usage
9. **Physical attack or vandalism** that could potentially impact electric power system adequacy or reliability
10. Cyber event that could potentially impact electric power system adequacy or vulnerability
11. Loss of electric service to more than 50,000 customers for one hour or more
12. Fuel supply emergencies that could impact power system adequacy or reliability

It is notable that the U.S. DOE OE-417 reporting program trigger criteria calls out physical security incidents as events needing to be reported within one hour of discovery by the utility.

Table 3. 2016 California Electric Physical and Cyber Events Reported in OE-417 reports

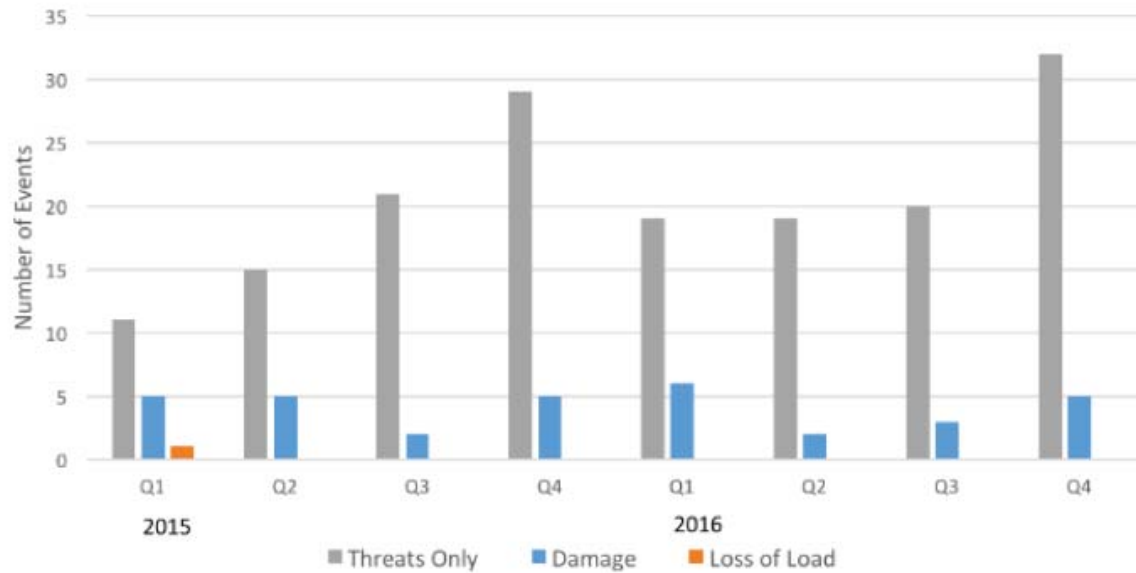
Month	Area Affected	Event Type	Demand Loss	Customers Affected
October	Mendocino Co.	Actual Physical Event	0	0
October	Imperial Co.	Vandalism	0	0
November	Stanislaus Co. San Joaquin Co. Alameda Co. Tuolumne Co.	Cyber Attack	0	0
November	California	Vandalism	0	0
December	Riverside Co.	Cyber Event	0	0

Source: FERC OE-417 reports

The OE-417 program has recorded few incidents of physical intrusions in California and nationally. NERC has concluded that the low numbers demonstrate that the electric industry's record of breaches is much lower than many other sectors (including government agencies). For 2017, NERC reported no major (Category 4 or 5) transmission outages. For 2015 and 2016, NERC reported one physical security incident that caused a loss of load (shown in **Figure 3**).

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Figure 3. Reportable Physical Security Events on Bulk Power System



Source: U.S. DOE, OE-417 Report of Electric Disturbance Events

Despite its historic value as a reporting tool, the OE-417 system's value appears to be less than its full potential due to inaccurate and miscategorized incident reporting that goes unnoticed, ostensibly due to staff bandwidth limitations at regulatory agencies such as NERC. A recent example would be an April 21, 2017, fire⁴⁶ at a PG&E distribution substation at downtown San Francisco's western edge that resulted in an extended loss of power to some 90,000 accounts during peak business hours, and led the city and county of San Francisco to sue to recover losses.⁴⁷ The incident, which took out power at the CPUC and caused the agency to close for the business day, was reported by PG&E via OE-417 as a "systems operations" event.⁴⁸

As it stands, the OE-417 reporting process provides some additional value for the Commission because these reports provide a secondary source of information on national trends, and vandalism incidents are not captured by CPUC emergency reporting. For this reason alone, staff recommends that jurisdictional utilities begin to copy the CPUC's Electric Safety and Reliability branch of SED and the Grid Planning and Reliability section of Energy Division anytime an OE-417 report is filed. Such filings will be treated in accord with prevailing State and Commission

⁴⁶ <http://www.latimes.com/local/lanow/la-me-san-francisco-power-outage-20170421-story.html>

⁴⁷ <http://www.sfgate.com/bayarea/article/SF-to-dun-PG-E-for-187-000-in-losses-during-11125425.php>

⁴⁸ <https://www.oe.netl.doe.gov/oe417.aspx>

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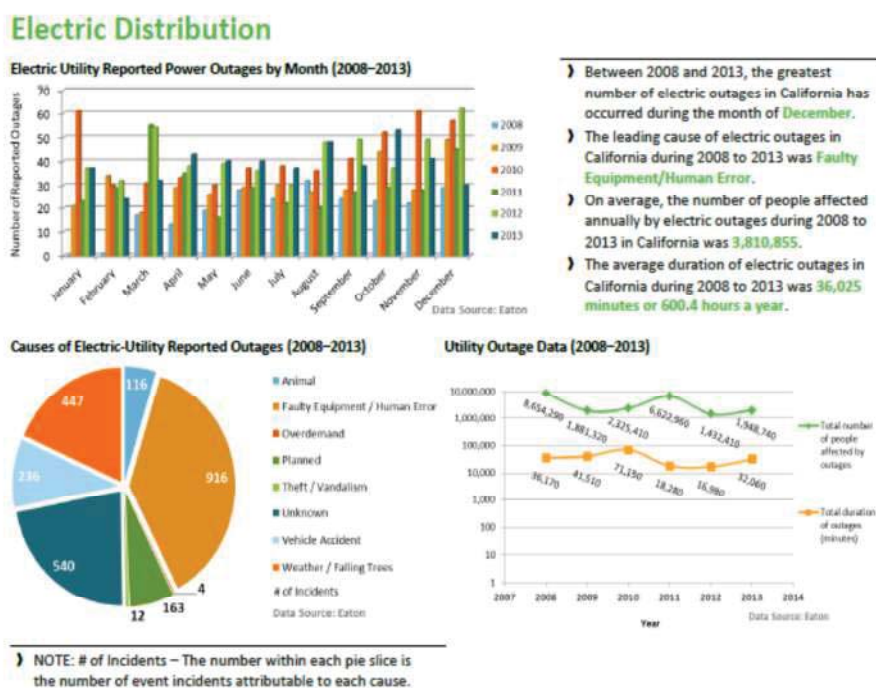
policy surrounding the safeguarding of sensitive information and exemptions from public disclosure.

5.1.3 U.S. DEPARTMENT OF ENERGY – OTHER DATA AND TRENDING RESOURCES

The U.S. DOE has published a series of State Energy Risk Assessments, with the intent of supporting public decisions about infrastructure, resiliency, and asset management. This is a joint effort with the National Association of Regulatory Commissions (NARUC), the National Association of State Energy Officials (NASEO), the National Conference of State Legislatures (NASL), and the National Governors Association (NGA).

California's *state and regional energy risk profile*, see **Figure 4**, below, presents risk factors typically attributed to California's energy infrastructure. NERC identifies faulty equipment/human error as California's primary cause of electric transmission outages. The risk profile also provides 2008-2013 data on transmission outages and causes. The data indicate that the *primary electric-outage risks are weather, natural disaster, or equipment failure*.

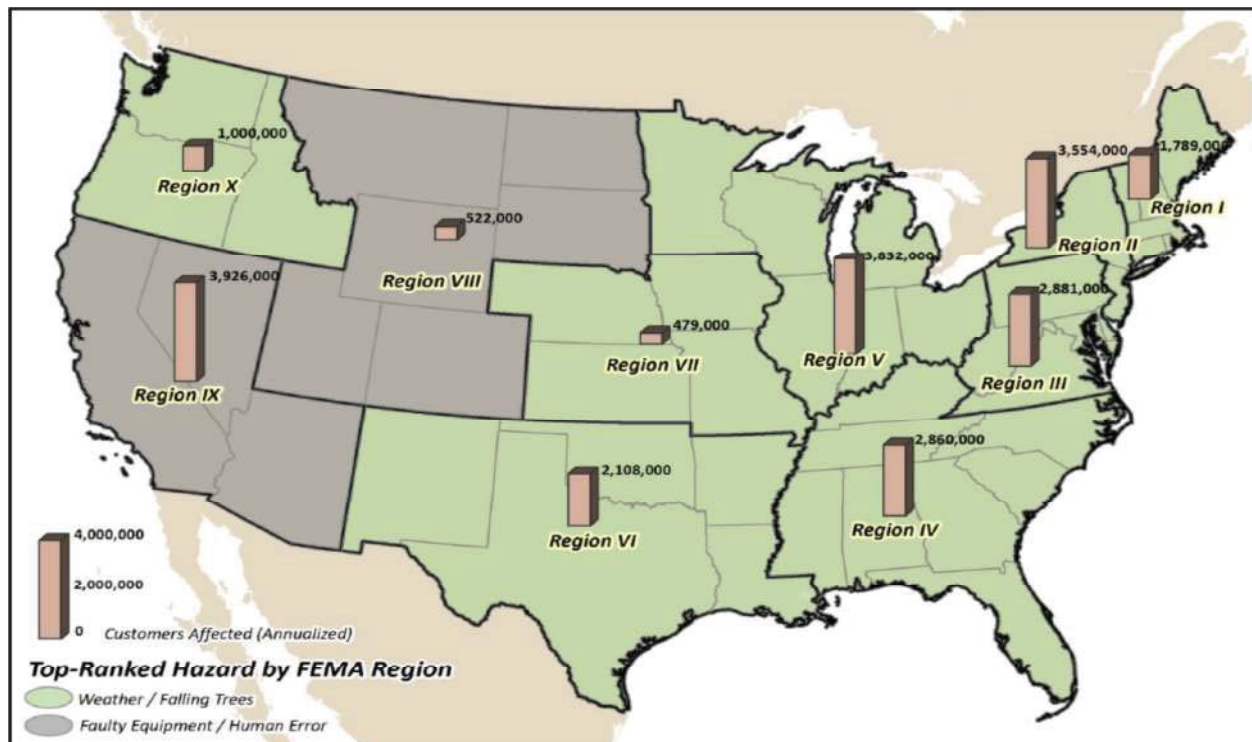
Figure 4. State of California Electric Risk Profile



Source: [U.S. Department of Energy](#), Office of Electricity Delivery and Electric Reliability

As shown in **Figure 5**, below, U.S. DOE has also examined electric distribution system outages by region for the United States. It was found that the western region consisting of California, Nevada, and Arizona has the highest number of annual distribution outages (3,926,000) with the leading cause determined to be faulty equipment or human error.

Figure 5. Electric Distribution Outages by FEMA Region by Argonne National Laboratory



Source: U.S. DOE, National Electricity Emergency Response Capabilities, August 2016

To date, impact on grid reliability attributable to physical security incidents there has been rare and limited. Where such events have occurred, the number of customers impacted has been small and restoration of service has typically occurred within 24 hours. The fact that actual physical attacks comprise an insignificant share of electric system incidents has been cited in some news articles⁴⁹ as an indication that fears of malicious attacks are “overstated.”

⁴⁹ A June 15, 2017, Bloomberg/BNA article asserted that many supposed reported physical security incidents were not sabotage with resulting loss of power or even vandalism, but rather pointed to petty theft. The problem stems, the article suggested, from confusion resulting from a 2010 change to OE-417 reporting requirements. Affected

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However, the available documentation actually provides a sound basis for a public policy approach that *balances physical security efforts, where appropriate, with other utility efforts to ensure resilience of service*. Such an approach is valuable, not just for addressing physical security, but also for reducing impacts from weather events or the infamous “other” causes of system disturbances that more commonly impair system reliability.

5.1.4 INSURANCE INDUSTRY – NATIONAL INSURANCE CRIME BUREAU

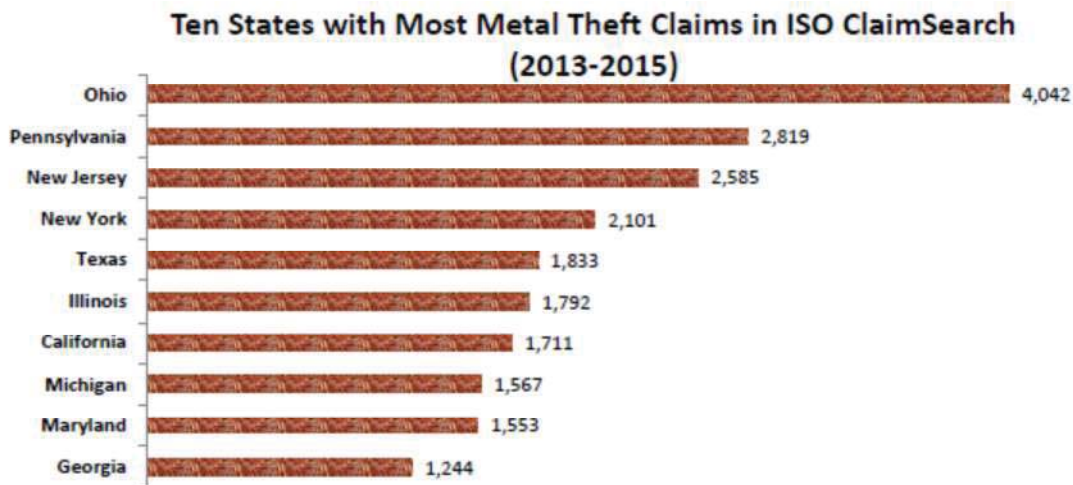
An effective example of private-industry methodology employed in recording and trending physical security incidents would be that of the National Insurance Crime Bureau (NICB). The NICB tracks those incidents linked to its 1,100 members and – using data analytics, investigations, and training -- represents insurers in cooperating with law enforcement and others to deter crime and insurance fraud.

NICB recognizes the value of information tracking and sharing, and its reporting system offers what appears to be the nation’s best source for data on metal theft. The reporting system’s success is contingent on member insurers comprehensively reporting all claims involving the theft of metal, typically copper. While NCIB does not, provide information specific to the electric industry, its data provides an accurate assessment of metal theft activity state by state, which would be representative of physical security issues linked to electric distribution facilities. This is because copper theft is perhaps the most common incident type at electric distribution facilities. As shown in **Figure 6** below, from 2013-2015 NICB data shows that California was among the top ten states in metal theft claims.

However, when adjusted for population size, California is not within the top ten states with metal theft problems. Compared with top ranked state Ohio at over 30 claims per 100,000 residents, California had just 4.4 claims, ranking it 41 of 50 states in metal theft claims on a per capita basis.

entities, it seems, are confused about when to file a report and how to file it, and so choose to err on the side of caution and thus over-report. *Malicious Attacks on Electric Grid Facilities Over-Reported*, Bloomberg Business News.

Figure 6. 2013-2015 Ten States with Most Metal Theft Incidents



Source: National Insurance Crime Bureau, [Metal Theft Claims Down 8% Since 2012](#), September 9, 2015

The insurance industry model for tracking physical security events holds several advantages over the existing electric industry approach. For one, this tracking function is performed by an organization that has information management and data analytics as its primary mission and possess the resources to provide meaningful, accurate information to its members. This information generated by the insurance industry has superior granularity and quality assurance than the reporting systems employed by the CPUC or U.S. DOE.

6 EXCHANGE OF AND ACCESS TO HIGHLY CONFIDENTIAL AND SENSITIVE INFORMATION

Information sharing can reliably be counted on as a high profile issue in Commission matters, and this proceeding is shaping up to be no different. The crux of the issue here appears to be How to balance disparate and well-intended, but seemingly conflicting goals surrounding the Commission's responsibility to protect the public and the Commission's responsibility to provide the public with access to information?

The first goal would be the seemingly legitimate limitation of information dissemination to safeguard against data unintentionally falling into the wrong hands. The conflicting second goal would be the transparency and openness in government. A third consideration and priority

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would be the Commission's ability to have rapid and unfettered access to the full set of facts and data surrounding a utility issue or impending crisis. Thus, the Commission, its staff, and regulated entities recognize that an effective physical security program will need to facilitate the quick and easy exchange of vital information among participants.

Further complicating matters are legitimate concerns surrounding cyber security. As a result of a series of high-profile identity theft and ransomware incidents in 2016 and 2017, it is now well recognized at both the security-expert and consumer levels that remote exchange of digital information is highly vulnerable to cyber threats.

The Commission relies heavily on the data request process as a primary means for staff to carry out its regulatory duties. For the vast majority of cases, CPUC staff is able to obtain at least partial fulfillment of the requested data, which may or not be confidential, in electronic format⁵⁰ and within two to three weeks without the need to meet with or hold a complex conversation with IOU staff.

Still, there are cases in which a standard data request to a utility may be a poor fit given the sensitivity of the information requested. The Legislature within SB 699, granted the Commission authority to withhold public disclosure of certain information with the intent of preventing homeland security-scale secrets from being exploited by malicious actors. As part of this proceeding, SED and utility staff have cooperated to try to determine new proposed thresholds and definitions for *highly confidential* and *sensitive* information, categories more restrictive and unusual than the relatively common *confidential*⁵¹ information category described in PU Code Section 583. Additionally, the proceeding has attempted to determine if these new categories of information can be exchanged and accessed by electronic means. This chapter presents background, existing status, and a look at what may lie ahead on the Commission's evolving treatment of sensitive information.

⁵⁰ The CPUC has various electronic data transfer tools with varying degrees of perceived cyber security.

⁵¹ Broad rules exist for restricting public disclosure of utility records and designating them as confidential, with private consumer information and use data (GO 77-M) being two of the more common items. Probably more routine in their application to data submitted to the Commission, is the utilities' use of GO 66-C, which among other things, broadly protects "Reports, records, and information requested or required by the Commission that, if revealed, would place the regulated company at an unfair business disadvantage."

6.1 EXISTING FEDERAL STANDARDS AND FERC PROTOCOLS

Existing standards for the sharing of information on critical electric infrastructure by the U.S. electric industry has been shaped by Federal rules, which define critical electric infrastructure information that warrants secure management by all parties.

Treatment of sensitive information regarding critical energy infrastructure has been a Federal priority issue since 9/11, with FERC adoption of PL02-1000 in October 2001. FERC has since actively updated its information sharing policies. In 2003, FERC adopted Order No. 630, which included a definition of *Critical Energy/Electric Infrastructure Information* (CEII). CEII-designated information is treated by FERC as privileged and confidential, not subject to the Freedom of Information Act (FOIA). Information categorized as CEII is limited and includes specific engineering, security, and design details about existing or proposed critical infrastructure. Most recently, in 2016, FERC adopted Order No. 833, which added Section 215A to the Federal Power Act to address security and resilience of energy infrastructure.⁵²

Access to CEII is restricted because it conveys strategic information beyond the location of critical infrastructure and could be useful to a person planning an attack on critical infrastructure. Further details of FERC's approach to information access, and definitions employed for information sharing policies, may be found in **Appendix 2**.

6.2 COMMISSION POLICIES AND RECENT DECISIONS ON INFORMATION SECURITY

The issue of confidential information exchange between utilities and the Commission dates back at least 40 years and is addressed in the PU Code and Commission General Orders. Public Utilities Code Section 583 sets forth a process for dealing with claims of confidentiality but does

⁵² The definition of Critical Energy/Electric Infrastructure Information is codified in Section 388.113(c), Chapter I, Title 18, Code of Federal Regulations, which governs the procedures for submitting, designating, handling, sharing and disseminating CEII submitted to or generated by FERC. Critical Electric Infrastructure Information is exempt from mandatory disclosure under the Freedom of Information Act, 5 U.S.C. 552(b)(3), and shall not be made available by any Federal, State, political subdivision or tribal authority pursuant to any Federal, State, political subdivision or tribal law requiring public disclosure of information or records pursuant to section 215A(d)(1)(A) and (B) of the Federal Power Act.

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not contain any substantive rules on what is and is not appropriate for protection.⁵³ GO 66-C, first adopted in 1974, and updated in 1982 (and superseded by GO 66-D in 2018) identifies procedures for the treatment of public records at the Commission. GO 66-C identified all Commission records as public unless they fall within a short list of exemptions.

6.3 GO 66-D AND CONFIDENTIAL MATRICES

Under Rulemaking (R.) 14-11-001, now in progress, the Commission has been examining public access to public records with the goal of providing clarity on when information should be considered confidential. On September 28, 2017, the Commission completed the first of two phases of the rulemaking by adopting GO 66-D and new administrative processes for submission and release of potentially confidential information.⁵⁴ GO 66-D replaced GO 66-C, and became effective in January 2018. GO 66-D specifies a process for:

1. Regulated entities and the public to submit information with a claim of confidentiality
2. The public to submit requests for information per the California Public Records Act; and
3. The Commission to determine whether a claim of confidentiality is lawful and appropriate

In the second phase of the confidentiality rulemaking, the Commission expects to address a significant change included in GO 66-D regarding the concept of “Confidential Matrices.” The term describes a Commission determination that specific categories of information are confidential per Section 3.4 of GO 66-D. The determination would be made prior to submission to the CPUC of such information, and would apply broadly to a category of documents. If information has been submitted in compliance with a specific confidential matrix, it would not be released per a California Public Records Act request absent an Order of the Commission. This would be applicable to physical security information from the utilities.

The utilities endorse a confidential matrix consistent with FERC protocols that uses the CEII designation for a class of information relating to critical energy infrastructure physical- and cyber security sensitive information. It also cites a category of information defined in FERC

⁵³ D.06-06-066 at 27, as modified by D.07-05-032.

⁵⁴ CPUC Decision 16-08-024, September 28, 2017.

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regulation, *Sensitive Security Information* (SSI).⁵⁵ The physical security rulemaking is somewhat intertwined with the confidentiality rulemaking as development of a confidential matrix for the electric industry would determine when information is to be categorized as CEII and SSI, and would impact how physical security information is to be shared between electric utilities and the Commission.

SED staff continue to closely monitor the R.14-11-001 proceeding. While the CEII and SSI designations are consistent with FERC protocols, the Commission would need to define the type of information that qualifies for such designation and how the Commission would vet any proposed request for designation. It is expected that the confidentiality proceeding will conclude in early 2018, approximately the same time that the current Phase 1 of the physical security rulemaking would be coming to a close. SED staff believes that the confidential matrix proposed by the electric utilities would be adequate and generally consistent with the outcome sought by the physical security proceeding.

Table 4. Joint Energy Utilities Working Group Matrix of Confidential Materials Relevant to Physical Security of Electric Distribution Systems

Type of Information	Examples	Justification
Personally identifiable information (PII) of regulated entity Customers	Social Security Numbers	
Personally Identifiable Information of Employees or Contractors	Names, home and email addresses, telephone numbers	
Investigations of Regulated Entities	Orders Instituting Investigation, Audits	

⁵⁵ As part of the confidentiality proceeding, the Commission requested that parties submit proposals for confidential matrices. Working groups were formed for various utility industries regulated by the Commission for the purpose of developing matrices applicable to their industry. California electric utilities formed a Joint Energy Utilities Working Group and jointly filed a proposed matrix on October 3, 2017 that identifies specific categories of information proposed as being exempt from PRA requests.

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Corporate, Financial and Proprietary Records	Tax Returns, Board Minutes, Non-public Company Financial Information	
Critical Energy Infrastructure and Physical- and Cyber Security Sensitive Information	<ul style="list-style-type: none"> ▪ Critical Energy/Electric Infrastructure Information (CEII)⁵⁶ ▪ Sensitive Security Information⁵⁷ (SSI) ▪ NERC Critical Infrastructure Protection (CIP) Information ▪ Physical facility information ▪ Electric Facility Information 	<p>Protected under Gov't Code §§6254€; 6 USC §131(5); 68 Fed. Reg. 9857 (DOE Mar 3 2003) (final rule); Cal. Pub. Util. Code §364(d).</p> <p>18 CFR 388.113©; FERC Orders 630, 643, 649, 662, 683, and 702 (defining CEII); 68 Fed. Reg. 9862 (DOE Mar 3 2003) (final rule)</p> <p><u>Critical Infrastructure Information</u>⁵⁸ Gov't Code 6254€, (k), (ab)</p>

Source: Energy utility working group filing in R.14-11-001⁵⁹

6.1 PROTECTED CRITICAL INFRASTRUCTURE INFORMATION (PCII) PLATFORM

The Critical Infrastructure Information Act of 2002 established the Protected Critical Infrastructure Information (PCII) program⁶⁰ as a secure sensitive information portal for data on the nation's infrastructure. The PCII platform is intended as an information depository and -

⁵⁶ 18 CFR §388.113© defines "critical energy infrastructure information" as "specific engineering, vulnerability, or detailed design information about proposed or existing critical infrastructure" that

- I. Relates details about the production, generation transportation, transmission, or distribution of energy,
- II. Could be useful to a person in planning an attack on critical infrastructure,
- III. Is exempt from mandatory disclosure under the Freedom of Information act, 5 USC 552 and
- IV. Do not simply give the general location of the critical infrastructure.

⁵⁷ 49 CFR 1520.5(a) defines "sensitive security information" as:

Information obtained or developed in the conduct of security activities, including research and development, the disclosure of which TSA has determined would –

1. Constitute an unwarranted invasion of privacy 9including but not limited to information contained in any personnel, medical, or similar file);
2. Reveal trade secrets or privileged or confidential information obtained from any person; or
3. Be detrimental to the security of transportation

⁵⁸ Defined in 6 USC 131(3).

⁵⁹ Southern California Edison, Proposed Matrix of the Joint Energy Utilities Working Group Pursuant to Assigned Commissioner's Ruling Regarding Phase 2B, October 3, 2017.

⁶⁰ More at: <https://www.dhs.gov/pcii-program>

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sharing resource to advance homeland security goals by lowering barriers to and increasing privacy in the exchange of sensitive information between U.S. DHS and entities in allied fields.

All Information granted PCII status is automatically exempt from compliance with Freedom of Information Act (FOIA) requests or requests from any public entity. Similarly, PCII data are exempt from disclosure in civil litigation and from regulatory use purposes.

Clearance for PCII access requires rigorous background screening. Eligible staff or contractors of Federal, state, local, tribal, or territorial governments must complete PCII training; be employed in homeland security duties; and have demonstrated a valid need for access to particular information.

In California, one example of the possible application of PCII might be a utility or operator sharing details of electric grid and generation assets that would allow DHS staff to consider these facilities within the overall and emerging threat landscapes. A second example might be for Commission staff to retrieve sensitive information in real-time and via a secure platform from utilities regarding their electric assets. The existing regulatory-use exemption tied to PCII data may complicate the Commission's reliance of the platform for routine business, but the use of PCII merits further consideration, particular in the event of an emergency.

7 UTILITY GENERAL RATE CASES INFORMING PHYSICAL SECURITY EFFORTS

One expected outcome of the Physical Security rulemaking is a new process for utilities (both investor owned and publicly owned) to better identify assets that may be vulnerable to attacks or disruptions that pose a substantive threat to physical security or cause service disruptions and devise plans for mitigating the risks.

Eventually, for CPUC jurisdictional utilities, the costs of such preventive measures – whether in the form of “hardening” assets against attack, or ensuring that any disruptions to service are minimized by bolstering the resiliency of the system – would be accounted for in General Rate Case applications. Such costs would be separate from and additional to those incurred to meet federal requirements for protecting Critical Infrastructure; in particular, the CIP-014 protocols that are overseen by the NERC and subject to rulemaking by the FERC.

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As a result of the physical security rulemaking, and as an outcome of the Safety Model Assessment Proceeding (S-MAP) process and Risk Mitigation Assessment Phase (RAMP) for identifying and mitigating safety risks in GRCs, the Commission anticipates greater transparency about what utilities are doing to enhance physical security and at what cost to ratepayers.

An additional expected outcome would be a greater consistency in the reporting of plans and expenditures among the utilities whose quality and quantity of information they provide to the CPUC about physical security spending now varies widely.

The following narrative briefly describes how physical security has been documented in the most recent GRCs.

Pacific Gas and Electric Company

Despite the enhanced physical security upgrade program announced by PG&E in the wake of the Metcalf incident, the IOU did not provide much information in its most recent GRC covering the 2016-2018 period (A.15-09-001). In its GRC testimony, PG&E noted that costs associated with physical security at distribution substations are bundled together in Major Work Category 58, via four subprograms covering safety, security, fire protection, and seismic enhancements.

“Expenditures include the replacements or upgrades of substation fences, security cameras and card readers, fire suppression systems and seismic retrofits to control buildings.” At the time of its filing, PG&E did not project any expenditures to meet future requirements under SB 699/R.15-06-009, and it did not plan to recover any costs during this rate case cycle.

That said, the utility documented over \$1 million in distribution substation security measures in 2014, with a varied projection of expenditures through 2019 approaching \$6 million in total:

Table 5. (\$000) PG&E Distribution Substation Security Spending 2014-2019; PG&E, pp. 12-27

Substation	2014 (actual)	2015 (forecast)	2016	2017	2018	2019	Total
Security	\$1,070	\$461	\$364	\$1,300	\$1,300	\$1,300	\$5,795

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The settlement of the PG&E GRC approved by the Commission in D.17-05-013 did not alter PG&E's forecast spending on substation security. In November 2017, the utility will file a first-of-its-kind RAMP for the next GRC cycle, in which it is expected to provide more details on risks and mitigations associated with both physical- and cyber security.

Southern California Edison

In contrast to PG&E, SCE provided a great deal of information about its physical security efforts, but at part of testimony on Corporate Security (SCE-7, Vol. 5). Its documentation was largely about expenditures and projects to comply with the strengthening of CIP-014 standards at the federal level, with no detailed information about distribution-level asset security. However, the utility's testimony devoted to transmission and distribution substation construction (SCE-02, Vol. 6) provided a high level of expenditures for substation physical security during the GRC period 2016-2020, with a breakout for costs that are CPUC jurisdictional amounting to over \$49.5 million for the forecast period.

SCE noted that it has 188 transmission substations and 677 distribution-level substations. Many substations reduce voltage from transmission level to distribution level voltages, so are dual jurisdictional.

Table 6. (\$000) Substation Construction and Maintenance, Total and CPUC Jurisdictional; SCE-06, Vol. 6, p.2

	2016	2017	2018	2019	2020	Total
Total Substation Physical Security	\$22,341	\$51,617	\$25,641	\$22,404	\$23,877	\$145,880
CPUC Jurisdictional	\$10,040	\$12,226	\$9,403	\$8,798	\$9,077	\$49,544

Within its substation physical security program, there are three categories of spending: Copper theft mitigation program, CIP-14 compliance and lower-tier in terms of potential impacts on the system if a physical attack or breach occurs. SCE described physical upgrades for CIP-14 compliance, including: improvements to walls, reinforcement of gates, concealing key assets,

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and improved cameras, alarms and lighting. The utility projected full upgrades for about 7 substations per year for CIP-14 program and as many as 29 per year for the lower-tier substations. The copper theft mitigation program largely entails additional fencing and lighting where needed.

Table 7. (\$000) SCE Substation Physical Security Enhancement; SCE-02, Vol. 6, p. 46

Program	2014	2015	2016	2017	2018	2019	2020	Total
Copper Theft	N/A	\$3,330	\$8,151	\$8,321	\$8,530	\$8,798	\$9,077	\$46,207
Tier 1 CIP-014	\$10,861	\$14,344	\$14,190	\$42,550	\$9,052	N/A	N/A	\$90,997
Tier 2-4	N/A	N/A	N/A	\$746	\$8,059	\$13,606	\$14,800	\$37,211
Total	\$10,861	\$17,674	\$22,341	\$51,618	\$25,640	\$22,404	\$23,877	\$174,414

Note: Except for expenditures under the Copper Theft prevention program, these figures relate mainly to FERC jurisdictional transmission assets

San Diego Gas & Electric Company

SDG&E's most recent GRC was for TY 2016 (A.14-11-003). Unlike SCE, the utility's testimony does not provide much detail on physical security expenditures to comply with federal CIP-014, noting only that such expenditures would fall under Infrastructure Integrity, Physical Security and Environmental costs. For the three-year GRC period, SDG&E projected a total \$100.5m for capital for this category, and an O&M (operations and maintenance) budget of \$11.22 million for TY2016 (future year O&M spending was established under the attrition year adjustments approved in the final GRC decision D.16-06-054).

For its GRC, SDG&E documented a steady-state physical security budget of \$834,000 per year in 2014-2016, essentially the same as actual 2013 spending. The cost justification was based on increase compliance for critical infrastructure at 59 substations and to prevent copper theft and sabotage, according to SDG&E (SDG&E-09, p. 101). Among security measures in the program: video surveillance, nighttime illumination, access control door card readers, perimeter microwave intrusion detection and alarms. Security systems would be installed at all 230 KV cable locations.

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In its more recent 2019 GRC filing made in October 2017, the Sempra Utilities did not provide a budget for risk assessment for physical security of electric assets of SDG&E. However, some categories of risk mitigation would entail spending for physical security. For example, to reduce the “workplace violence” risk, SDG&E requests about \$3.4 million in physical security upgrades in 2019, and approximately \$340,000 for physical security awareness training.

8 CONCLUSIONS

It appears that the North American electric industry is in intermediate stages of fully harnessing the potential of security technologies and staff expertise, and integrating security and risk assessment values into the utility culture such that utility physical security ultimately is prioritized on par with safety and reliability.

With advances in and lower costs of monitoring equipment, IOU security operations centers are extending the reach and capability of their physical security staff. In the coming years, IOUs will continue to ramp-up hiring of security experts who possess the knowledge necessary to adapt physical security methodology to IOU culture and needs. These experts would be able to bring on line and integrate into their IOU's retrievable recordkeeping systems the ability to optimally cull, trend, and process the vast quantities of data brought about by recent advances in technology. IOUs are growing their security data collection, trending, and forecasting capabilities as an emerging new field of expertise within the electric utilities. Such staff expertise and specialization may better ensure that a utility's many divisions are sharing data points on emerging threats so as to inform a full and accurate grid security assessment.

California's electric IOUs are well ahead of many of their peer organizations in North America and are serving as physical security innovators within the electric industry. Driven in part by NERC CIP-014 regulations, California IOUs have upgraded security operations centers and have "hardened" select transmission and distribution facilities (incorporating security upgrades that include perimeter fencing, electronic monitoring equipment, and improved access control).

The IOUs are also continually testing new equipment to assess its potential and cost-to-benefit tradeoff. Still, while California IOUs have demonstrated they are well ahead of many of their peer utilities, they have some ways to go to attain their full physical security potential and competency.

8.1 ROOM FOR IMPROVEMENT IN DEMONSTRATING ADEQUACY AND COMPETENCY

As stated in the FERC order that led to CIP-014, it is essential that electric utilities “demonstrate that they have taken steps to address physical security risks and vulnerabilities.”⁶¹

IOU physical security efforts, staffing, and expertise appear to rely in large part on veterans of the military and law enforcement. While these expert backgrounds provide valuable rigor and standardization to physical security efforts, at times the tightlipped security culture they bring to the hinders the Commission’s efforts to ensure transparency. Uneven rapport and uneven resources put toward rapport building among the physical security staff at the three IOUs with SED was evident in in 2017 in the course of carrying out routine regulatory oversight functions.

The culture difference that exists between regulatory and martial professions that is now being felt within the halls of the utilities and the Commission will need to be bridged and crossed to facilitate appropriate oversight of the physical (and cyber) security activities of jurisdictional utilities. SED staff encourage the IOUs to provide a signal of their commitment to reform disclosure and information sharing.

In addition, SED staff have witnessed varying degrees of preparedness, cooperation, and openness in interactions with IOU staff overseeing threat and security efforts. There remain issues with IOU staff turnover, evidence of disorganization when there is a handoff of roles and responsibilities to newly assigned IOU staff, and when the left and right hands of a utility organization function seemingly without knowledge of the other’s actions.

Given the sizable expenditures put toward physical security as described above, there is an obligation for the utilities to better demonstrate and convey how these monies are being appropriately programmed, how grid assets are being adequately protected, and how risk is being managed in a responsible and optimal manner.

For now, as a result of this proceeding, the IOUs and SED staff appear to be in agreement that a balance can be found between safeguarding necessary classified-level information and ensuring that regulators are able to assess adequacy and competency without undue barriers and delays.

⁶¹ 146 FERC 61.166. *Reliability Standards for Physical Security Measures*, March 7, 2014.

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The Joint Utility Proposal – in whatever final form it may take – provides a potential solution to this need, and provides the Commission an initial platform for applying a standardized assessment and mitigation approach that represents a good beginning point.

9 RECOMMENDATIONS

9.1 SED STAFF RECOMMENDATION ON INCIDENT REPORTING

The CPUC has in place procedures for incident reporting by the utilities, but which do not specify physical security incidents.

Chapter 5 describes an existing mandatory U.S. DOE reporting system for emergency incidents associated with electric utility assets, and which includes physical security lapses and vandalism incidents. These OE-417 reports are prepared by California’s investor- and publicly-owned utilities in accord with NERC rules and are submitted to NERC and WECC.

The OE-417 reporting provides some additional value for the Commission because these reports provide a secondary source of information about national trends, and the inclusion of vandalism incidents is something not captured under CPUC emergency reporting. For this reason alone, *staff recommends that jurisdictional utilities copy the CPUC’s Electric Safety and Reliability branch of SED and the Grid Planning and Reliability section of Energy Division anytime an OE-417 report is filed.*

SED, which is the delegated lead within the Commission for CPUC incident reports, could then work to internally make improvements to make CPUC reports and OE-417 reports records more searchable, actionable, and adept to trend analysis.

9.2 POLICY RECOMMENDATIONS AND ADVISABLE GENERAL STRATEGIES

9.2.1 PURSUE INFORMATION-SHARING PARTNERSHIPS THAT OFFER LOW BARRIERS AND HIGH RETURNS

In the realm of providing for physical security of critical assets, it is vital to follow the example among federal law enforcement and intelligence agencies to proactively cooperate to exchange leads, information, and best practices. For the purposes of state-level security oversight efforts, we provide here examples of utility partnerships that can support this goal.

9.2.2 INTERAGENCY PARTNERSHIP EFFORTS

California's electric grid security concerns are ones shaped by factors perpetually subject to change. Fortunately, the State's industry and regulators are among the nation's most capable experts at responding and adapting to new threats, hazards, and vulnerabilities as they emerge.

In the post-9/11 environment, and in the wake of the U.S. intelligence, law enforcement, and customs agencies' communication shortcomings that led to establishing the Department of Homeland Security (U.S. DHS), collaboration among critical entities has become such an indispensable strategy that its importance is now largely understood by Americans even outside the security profession.

Similarly, collaboration and information sharing have become a new urgency for the U.S. electric industry in the years following the Metcalf incident. Increasingly, the formation of effective and innovative partnerships that bridge industry, regulators, emergency management, third-party, and law enforcement expertise are being looked to as a high-return, low-barrier-to-entry physical security strategy.

While still in progress, the physical security Phase 1 rulemaking appears to demonstrate how California can quickly assemble a functioning electric industry partnership bridging geography and other differences at nominal cost to locate solutions that make the grid and the public safer.

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There is reason to believe that the Commission – with the aid and cooperation of its partners – can repeat this outcome to continue in a leadership role in the pursuit of establishing permanent physical security partnerships. Indeed, as a California public institution, the Commission is unique in its significant resources, strong voice, reputation for positive progress, and regulatory power available to forge new public-private working alliances to advance the security of those industries it oversees.

There is precedent for the Safety and Enforcement Division to enter into interagency partnerships via memoranda-of-understanding with sister state agencies, including Cal-OES).⁶²

This MOU relationship allows for joint sharing of information and a seat at the table within response efforts to emergency situations. There is potential to expand such MOU relationships to other key agencies in the physical- and cyber security realm, including the network of law-enforcement intelligence fusion centers.

To this end, SED recommends that the informal Utility Physical Security Working Group formed for this proceeding (and which formulated the Joint Utility Proposal) continue to convene and be encouraged to engage with the Commission and its staff. SED should forge stronger ties and rapport with key physical security partners such as Cal-OES, and U.S. DHS, with participation by the utilities and their working group. Such collaborative efforts could help determine information-sharing platform standards, along with proactive exchange of tools and best practices to ensure that appropriate information on actionable threats, hazards, and vulnerabilities is available to relevant parties.

9.2.3 JOINT UTILITY PARTNERSHIP EFFORTS

As part of their compliance efforts to meet the challenges of critical infrastructure protections, utilities across the nation have joined in various task forces and working groups to share information and best practices. One example would be the member electric utilities within WECC's utility working group.

⁶² Available for download at: [http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Safety/Cal-OES%20CPUC%20MOU%20FINAL%20SIGNED\(1\).pdf](http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Safety/Cal-OES%20CPUC%20MOU%20FINAL%20SIGNED(1).pdf)

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Utilities have actively entered into mutual aid agreements to dispatch staff and resources outside of their service territories in the event of an emergency or catastrophic event affecting an allied member utility. Such agreements, which commit to deploying a surge of qualified technicians to an impacted area, allow for shorter response times and more thorough restoration of electric service. Whether for hurricanes, wildfires, or earthquakes, the nation's utilities have demonstrated a reliable record of coming to the aid of one another and American energy consumers under difficult and trying circumstances.

In recent years, this asset sharing approach has also been put to use as a kind of preventative measure, one example being a joint utility lending program for replacement distribution transformer equipment that can be rapidly dispatched to respond to an emergency outage in the event electric operations equipment is compromised. Such lending programs work as cooperative resource leveraging to boost utility deployment capabilities at reduced cost compared to each utility having to store maintain vast inventories of idle parts to hold in reserve and at the ready.

Such agreements might also be valuable for other types of utility equipment, and California electric utilities should focus additional attention to and demonstrate competency with modeling and *robust assessment of supply chain vulnerabilities* and inter-utility agreements to create a shared stockpile of certain scarce and high-priority equipment.

Given the inherent interdependencies associated with California's electric grid, actors responsible for its physical security should share resources and data to improve monitoring of operations that span utility territories. Working collaboratively, California utilities should identify and map nodes, choke points, and other key points along the edges of their service territories. Such practices hold potential to improve the ability to monitor statewide performance of the distribution system's various components, and to forecast and model impacts on these interdependent systems.

California utilities should consider the value of, and report back to the Commission with an opinion on, available tools such as the Environment for Analysis of Geo-Located Energy

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Information (EAGLE-I) managed by the U.S. DOE, which inputs data directly from energy sector partners, performs big data analysis, and shares situational awareness data.

California utilities should consider the value of, and report back to the Commission with an opinion on, U.S. DOE's new information classification system, "Critical Electric Infrastructure Information" (CEII) that facilitates voluntary sharing of critical electric infrastructure information between federal, state, and local government, and utilities.

9.2.4 PROTECT BY ENHANCING PREPAREDNESS AND PREDICTION CAPACITY

Similarly, California electric utilities, working with appropriate public agencies, should plan and practice response procedures for incidents targeting sector interdependencies and entailing coordination across entities or business lines.

- IOUs should include physical security incidents as components to be addressed within their emergency preparedness plans and drills.
- California electric utilities' regular planning and preparation for major outage incidents should incorporate physical security strategies.
- California electric utilities should be proactive to incorporate the latest modeling and quantitative risk analysis tools, methodologies, and expertise to record, categorize, and trend incidents to more thoroughly expose threats to the electric grid.
- California electric utilities should offer an opinion to the Commission on whether the U.S. DHS Security Regional Resiliency Assessment Program could have value in protecting California's distribution systems.⁶³
- Given the strong evidence⁶⁴ which suggests that California's primary risk of electric outages can be attributed to weather, natural disaster, or equipment failure, any rigorous distribution system resiliency plan would need to include strategies for addressing these three factors, which fall well outside of physical security parameters.

⁶³ This program consists of DHS conducting a regional analysis of critical infrastructure to address infrastructure resilience issues that could have regional or national consequences.

⁶⁴ U.S. DOE, California state energy risk profile.

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9.2.5 APPLY TECHNOLOGY, INNOVATION, AND INVESTMENT TO BOLSTER GRID RESILIENCY

California's electric utilities should improve their ability to monitor the grid's operating conditions and enhance their ability to pinpoint a problem and reroute power around any affected area.

California utilities should leverage grid modernization technologies including smart meters. Today's grid sensors are capable of detecting and monitoring grid anomalies to enable full integration of networked distributed energy resources. Deploying such devices would enable utilities to more quickly and precisely locate where actions and supplies are needed when incidents occur. Expanded networks of sensors hold promise for improving data transfer of diagnostics that monitor grid operations, improving response time and breadth. There is also great potential for improving reliability by way of automated responses to events. By beginning now, within a generation's time we may have an electric grid that is more flexible and agile, and would accommodate new plug-and-play technologies mindful of maximizing security and resilience. Such a future grid would be capable of restoring power with minimal intervention, ensuring that power flow can be quickly reconfigured, frequencies can be stabilized, and voltages can be controlled. And with utilities' improved outage response efficacy, there would be sizable operational cost savings.

9.2.6 WEAVE PHYSICAL SECURITY PRINCIPLES INTO UTILITY CORPORATE CULTURE AND EMBRACE CONSISTENCY STATEWIDE

To ensure more consistent physical security initiatives among the utilities, their security and response teams should identify those best practices which provide actionable steps for utilities to avert and respond to outage incidents.

Should the Commission find that statewide consistency among utilities' preparation for and response to outage incidents is desirable, utilities should demonstrate their coordination on mitigation, response, and recovery efforts for a range of threats. In the vein of the joint utility partnership opportunities described above, California electric corporations should form alliances to provide mutual aid and sharing of response resources when one or more members is in need of assistance due to an emergency incident.

9.2.7 CAPITAL PROJECTS IN THE PIPELINE

California electric utilities should be mindful of opportunities for grid architecture improvements when considering new security and resilience measures. After all, one desired outcome of California's smart grid initiative would be to enhance security and resilience.

Common approaches for incorporating physical security into transmission include: hardening of facilities, Protection in Depth (PID), and Crime Prevention Through Environmental Design (CPTED). Because practical and more economical physical security opportunities abound when projects are conceived with these measures in mind, there should be an emphasis on incorporating them into any substation from the time of its inception. Moreover, it should be the established policy of California and its electric facilities that these measures be considered and incorporated where practicable and appropriate within newly-constructed substations or substations that undergo a significant rehabilitation.

Similarly, each time a utility restores power after a major outage, an opportunity exists for the recovery effort to extend beyond mere in kind replacement. When rebuilding, opportunities often exist for improvements to the electric grid that go beyond mere restoration of prior infrastructure. Acting on such opportunities should be embraced by the utilities and encouraged by the CPUC.

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APPENDIX 1 | CIP-014 NERC GUIDELINES | PHYSICAL SECURITY AUDIT PROCESS

The following CIP-014 compliance steps summary describes the major components generally considered essential to any utility physical security program. The protocol is intended to be a means by which an electric utility may identify those critical assets whose impairment would have significant impact, and for determining those investments that would have the greatest impact in reducing the risk of major and cascading outages.

Initial Risk Assessment, R1

A risk assessment is performed on applicable facilities which are typically a subset of the overall portfolio of utility transmission assets. A specific risk assessment approach is not specified in the standard. This risk assessment must consider factors such as loss of communications, cascading outages, and impact on the bulk electric system. Risk assessments must be performed for individual assets and may not be combined.

Third Party Verification, R2

A third party such as a security firm must verify the initial physical security risk assessment by reviewing and verifying documents and data from the transmission owner. If the third party arrives at a different finding, the transmission owner may modify its assessment or document any technical basis for not modifying.

Evaluation of Threats and Vulnerabilities, R4

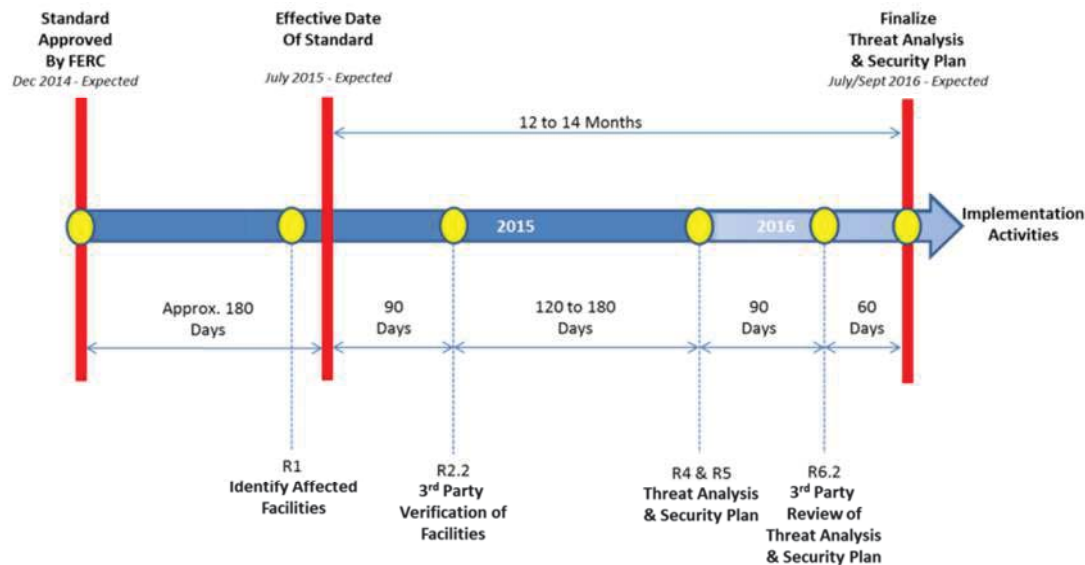
Any transmission owner that identifies a transmission asset subject to Requirement R1 and that is verified according to Requirement R2, shall conduct an evaluation of the potential threats and vulnerabilities of a physical attack for each of their respective assets. The evaluation must consider unique characteristics of the asset, prior history of attacks on similar facilities, and any intelligence or threat warnings received from sources such as local law enforcement, state or Federal agencies.

Next, a second review is to be conducted by a qualified third party to verify that the transmission owner conducted a robust threat and vulnerability assessment (TVA) of a physical

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attack for each critical transmission asset identified in R1, and verified according to R2, and that the assessment included appropriate mitigation measures.

Diagram 1. Expected timeframe for security plan implementation after CIP-014 protocol approved by FERC



Source: FERC CIP-014 Protocol

Physical Security Plan, R5

Each transmission owner shall develop and implement a physical security plan for each critical transmission asset. The plan shall include:

- Resiliency or security (mitigation) measures intended collectively to deter, detect, delay, assess, communicate, and respond to potential physical threats and vulnerabilities identified during the evaluation conducted in Requirement R4;
- Up to date and accurate law enforcement contact and coordination information;
- A timeline for executing the physical security enhancements and modifications;
- Provisions to evaluate evolving physical threats and their corresponding security measures.

ERO Audit of Security Plan, R6

Each Transmission Owner must have each preliminary security plan⁶⁵ audited by the NERC-designated responsible entity region. As described above, in the western states region including California, such an audit would be performed by WECC.^{66, 67}

⁶⁵ Review and verification of 1) the threat evaluation completed under Requirement R4 and 2) the unaffiliated third party review and the security plan(s) developed Requirement R5.

⁶⁶ WECC is the Western Electricity Coordinating Council and is the designated Electric Reliability Organization to the NERC for the western region. In this capacity WECC is a full-time regulatory authority that promotes CIP-014

APPENDIX 2| FERC Information Sharing Definitions

Critical Electric Infrastructure Information is defined by the FERC as information related to critical electric infrastructure, or proposed critical electrical infrastructure, generated by or provided to the FERC or other Federal agency other than classified national security information, that is designated as critical electric infrastructure information by the FERC or the Secretary of the Department of Energy pursuant to section 215A(d) of the Federal Power Act.⁶⁸

Critical Energy Infrastructure Information (CEII) is defined as specific engineering, vulnerability, or detailed design information about proposed or existing critical infrastructure that:

- (i) Relates details about the production, generation, transportation, transmission, or distribution of energy;
- (ii) Could be useful to a person in planning an attack on critical infrastructure;
- (iii) Is exempt from mandatory disclosure under the Freedom of Information Act, [5 U.S.C. 552](#); and
- (iv) Does not simply give the general location of the critical infrastructure.

Critical electric infrastructure is defined as a system or asset of the bulk-power system, whether physical or virtual, the incapacity or destruction of which would negatively affect national security, economic security, public health or safety, or any combination of such matters.

standards and other electric security objectives by way of education and enforcement. More at http://www.nerc.com/pa/comp/Resources/ResourcesDL/2017_ERO_CMEP_IP.pdf

⁶⁷ Concurrent with the implementation of CIP-014, physical security audits by approved third parties were initiated in 2016. These audits include facility visits and inspections to determine if CIP-014 security plans are being appropriately implemented by transmission owners and to verify that proposed mitigations are appropriate solutions for the set of security concerns identified. Audit findings are confidential and privy to the WECC, the NERC/FERC, and the transmission owner. Regulatory Commissions such as the CPUC may not access these audit records.

⁶⁸ Critical Electric Infrastructure Information is exempt from mandatory disclosure under the Freedom of Information Act, 5 U.S.C. 552(b)(3).

Critical infrastructure is defined as existing and proposed systems and assets, whether physical or virtual, the incapacity or destruction of which would negatively affect security, economic security, public health or safety, or any combination of those matters.

Criteria and procedures for determining what constitutes CEII

The following criteria and procedures apply to information labeled as CEII:

(1) For information submitted to the FERC:

(i) A person requesting that information submitted to the FERC be treated as CEII must include with its submission a justification for such treatment in accordance with the filing procedures posted on the FERC Web site at <http://www.ferc.gov>. The justification must provide how the information, or any portion of the information, qualifies as CEII, as the terms are defined in paragraphs (c)(1) and (2) of this section. The submission must also include a clear statement of the date the information was submitted to the FERC, how long the CEII designation should apply to the information and support for the period proposed. Failure to provide the justification or other required information could result in denial of the designation and release of the information to the public.

(ii) In addition to the justification required by paragraph (d)(1)(i) of this section, a person requesting that information submitted to the FERC be treated as CEII must clearly label the cover page and pages or portions of the information for which CEII treatment is claimed in bold, capital lettering, indicating that it contains CEII, as appropriate, and marked "DO NOT RELEASE." The submitter must also segregate those portions of the information that contain CEII (or information that reasonably could be expected to lead to the disclosure of the CEII) wherever feasible. The submitter must also submit to the FERC a public version with the information where CEII is redacted, to the extent practicable.

(iii) If a person files material as CEII in a complaint proceeding or other proceeding to which a right to intervention exists, that person must include a proposed form of protective agreement with the filing, or identify a protective agreement that has already been filed in the proceeding that applies to the filed material.

(iv) The information for which CEII treatment is claimed will be maintained in the FERC's files as non-public until such time as the FERC may determine that the information is not entitled to the treatment sought. By treating the information as CEII, the FERC is not making a determination on any claim of CEII status. The FERC retains the right to make determinations with regard to any claim of CEII status at any time, and the discretion to release information as necessary to carry out its jurisdictional responsibilities. Although unmarked information may be eligible for CEII treatment, the FERC will treat unmarked information as CEII only if it is properly designated as CEII pursuant to FERC regulations.

(v) The CEII Coordinator will evaluate whether the submitted information or portions of the information are covered by the definitions in paragraphs (c)(1) and (2) of this section prior to making a designation as CEII.

(vi) Subject to the exceptions set forth in paragraph (f)(5) of this section, when a CEII requester seeks information for which CEII status has been claimed, or when the FERC itself is considering release of such information, the CEII Coordinator or any other appropriate FERC official will notify the person who submitted the information and give the person an opportunity (at least five business days) in which to comment in writing on the request. A copy of this notice will be sent to the requester. Notice of a decision by the FERC, or the CEII Coordinator to make a release of CEII, will be given to any person claiming that the information is CEII no less than five business days before disclosure. The notice will respond to any objections to disclosure from the submitter that are not sustained. Where applicable, a copy of this notice will be sent to the CEII requester.

Duration of the CEII designation

All CEII designations will be subject to the following conditions:

(1) A designation may last for up to a five-year period, unless re-designated. In making a determination as to whether the designation should be extended, the CEII Coordinator will take into account information provided in response to paragraph (d)(1)(i) of this section, and any other information, as appropriate.

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(2) A designation may be removed at any time, in whole or in part, if the FERC determines that the unauthorized disclosure of CEII could no longer be used to impair the security or reliability of the bulk-power system or distribution facilities or any other form of energy infrastructure.

(3) The FERC will treat CEII or documents marked as CEII as non-public after the designation has lapsed until the CEII Coordinator determines to un-designate the information.

(4) If a CEII designation is removed, the submitter will receive notice and an opportunity to comment. The CEII Coordinator will notify the submitter of the information and give the submitter an opportunity (at least five business days) in which to comment in writing prior to the removal of the designation. Notice of a removal decision will be given to any submitter claiming that the information is CEII no less than five business days before disclosure.

CEII Coordinator

FERC designates staff to serve as a CEII Coordinator. This role is responsibilities for reviewing all requests for CEII designations, determining whether the information meets CEII criteria.

FERC has established procedures through 18 CFR 388.112 for designating information contained in a particular document as privileged. Any party requesting that material be treated as privileged information must include a justification for such treatment and how information qualifies as CEII as defined in Federal Regulations. They must also provide how long the CEII designation should apply to aforementioned information. This information is evaluated by the CEII Coordinator to determine if the submitted information is covered by the FERC definitions in CEII.

APPENDIX 3 | LOG OF PUBLIC WORKSHOPS

Workshop 1, Cal-OES Headquarters, Mather, May 2, 2017

Topics:

- Information Sharing for Critical Infrastructure Protection
- Establishing Proceeding Rules of Engagement for Input and Testimony on Sensitive Subjects
- Establishing Protocols for Data Access and Transfer

Workshop 2, CPUC Headquarters, San Francisco, May 31, 2017

Topics:

- Grid Security and Resiliency According to NERC
- CIP-014 Regulations and Implementation
- SMUD Case Study
- Distribution System Risk and Resiliency Best Practices

Workshop 3, Southern California Edison Headquarters, Rosemead, June 21, 2017

Topics:

- Physical Security Assessments
- Incident Response and Resiliency
- Tracking Physical Security Incidents
- Distribution System Risk Resiliency and Vulnerability Prevention
- Utilities Straw Proposals

Workshop 4, CPUC Headquarters, San Francisco, September 29, 2017

Topics:

- Joint Utilities Straw Proposal
- Qualifications of Third Party Reviewers
- CPUC White Paper

California Public Utilities Commission | Safety and Enforcement Division

Physical Security of Electric Facilities | R.15.06.009 | CPUC Safety and Enforcement Division

May 2, 2017 | Workshop 1 | 9:30 a.m. to noon

CalOES Offices | 3650 Schriever Avenue, Room MPR 1 & 2 | Mather, CA

WORKSHOP AGENDA

9:30- 10:00 a.m. Opening Remarks by CPUC President *Michael Picker*, Commissioner *Cliff*

Rechtschaffen, and Administrative Law Judge *Gerald Kelly*

10:00 – 10:15 am Opening Remarks by Director of the Governor’s Office of Emergency Services, *Mark Ghilarducci* (delayed)

10:15 - 10:30 a.m. Overview of the Proceeding, *Laying the Ground Rules for Getting It Right*, *Arthur O’Donnell*, SED Risk and Safety Supervisor, CPUC

10:40- 11:40 a.m. Two-part Panel Discussion

Who Needs to Know – Balancing Security with Collaboration: *Information Sharing for Critical Infrastructure Protection*

- Determining the extent to which closed door sessions are desirable and warranted
- Determining who gets access and who does not
- Recommendations on qualifying criteria for individuals and entities
- Recommendations on any appropriate new protocols

Overview of Information Categories

- Existing information categories
- Any proposed new information categories and whether existing practices are sufficient

Moderated by *Arthur O’Donnell*, SED Risk and Safety Supervisor

Panelists

- *Scott Aaronson*, Executive Director, Security and Business Continuity, Edison Electric Institute
- *Herb Brown*, Director, Sacramento Fusion Center,
- *John Pespisa*, Director of Compliance, SCE
- *Christopher Vicino*, Director of Security and Emergency Management, LADWP

11:40 - noon When to Invoke PU Code Sec. 364(d) To Protect Critical Infrastructure

Brainstorming and Consensus Exercise Facilitated by SED staff

Noon ADJOURN

California Public Utilities Commission | Safety and Enforcement Division

Physical Security of Electric Facilities | R.15.06.009 | CPUC Safety and Enforcement Division
 May 31, 2017 | Workshop 2 | 9:30 a.m. to 4:00 p.m.
 CPUC Auditorium | 505 Van Ness Avenue | San Francisco, CA

WORKSHOP AGENDA

9:30- 9:35 a.m. Welcome and Introductions

Topic Area #1: Federal Statutes and Guidelines to Address Physical Security

Part 1: NERC National Perspective

9:35- 10:45 a.m. Grid Security and Resiliency According to the NERC

Carl Herron – North American Electric Reliability Corporation (NERC)

10:45- 10:55 a.m. **B R E A K TEN MINUTES**

10:55- noon CIP-014 | Critical Infrastructure Protection | Federal Rules Overview, Applicability, and Update on Implementation Rollout

Darren Nielsen – Manager, Cyber & Physical Security Audits, Western Electricity Coordinating Council

Richard Hyatt – Chair WECC Physical Security Work Group, Chelan County (Washington) PUD

John Pespsia – Director of NERC Compliance, SoCal Edison

Noon- 1:15 p.m. **L U N C H – one hour, 15 minutes**

Part 2: California Lens Perspective

1:15- 2:00 p.m. SMUD's Tenfold Drop in Facility Intrusions in Two Years – "Protect Your Borders" Paper Presentation

James Day, paper author, Sacramento Municipal Utility District

2:00- 2:40 p.m. Distribution System Risk and Resiliency Best Practices Discussion

Crowdsourced brainstorming and input exercise facilitated by SED staff

2:40- 2:55 p.m. **B R E A K FIFTEEN MINUTES**

2:55- 3:40 p.m. Achieving CIP-014 and PU Code Seamlessness: Weeding Out Potential Gaps and Areas of Redundancy and Conflict

Crowdsourced brainstorming and input exercise facilitated by SED staff

3:40– 4:00 p.m. Summary Recap and Roundup, SED staff

4:00 p.m. **A D J O U R N**

California Public Utilities Commission | Safety and Enforcement Division

Physical Security of Electric Facilities | R.15-06-009 | CPUC Safety and Enforcement Division
June 21, 2017 | Workshop 3 | 9:30 a.m. to 3:30 p.m.
SoCal Edison | 2244 Walnut Grove Ave. | Rosemead, CA
WORKSHOP AGENDA

9:30- 9:35 a.m. Welcome and Introductions

9:35- 10:05 a.m. What Are We Protecting Against? California Theft Intrusions Threat: Insurance
Industry Stats and U.S. DOE OE-417 Electric Disturbance Event and Incident Reports

SED staff presentation by Martin Kurtovich

10:05- 10:45 a.m. Physical Security Assessments: Threat Vulnerability and Security and Mitigation Plans, a Consultant Expert Perspective on CIP-014 Compliance

Harford Field III, Corporate Risk Solutions, Inc., Manager Consulting Services

10:45- 10:55 a.m. B R E A K TEN MINUTES

10:55- 11:45 a.m. Incident Response and Resiliency Presentation, Part I

Emergency preparedness and response plans, IOU perspective

Thomas Jacobus, SCE, Principal Manager, Business Resiliency

Robert Kang, Senior Attorney, SCE

11:45- 1:15 p.m. L U N C H – one hour, 30 minutes

1:15- 1:45 p.m. Incident Response and Resiliency Presentation, Part II

Emergency preparedness and response plans, POU perspective

Stephen E. Lafond, Riverside Public Utilities, Principal Engineer in Substation, Transmission, and Distribution Standards (Energy Delivery)

1:45- 2:25 p.m. Distribution System Risk Resiliency and Vulnerability Prevention Panel Discussion

Spare parts inventories, dispatch, and change-outs; deployment of mobile generator units; distribution system design, redundancy, and resiliency; backup capabilities such as switching, back-ties, and load transfer; equipment and best practices sharing strategies.

Raymond Trinh, PG&E, Manager in Substation Asset Strategy and Reliability

Stephen E. Lafond, Riverside Public Utilities, Principal Engineer

Alex Salinas, SCE, Principal Manager, Technical Support

Moderated by Arthur O'Donnell, SED Risk and Safety Assessment Supervisor

2:25- 2:30 p.m. B R E A K FIVE MINUTES

2:30- 3:30 p.m. Utility Straw Proposal

Presentations by the utilities and discussion

3:30 p.m. A D J O U R N

California Public Utilities Commission | Safety and Enforcement Division

Physical Security of Electric Facilities | R.15-06-009 | CPUC Safety and Enforcement Division
September 29, 2017 | Workshop 4 | 10:00 a.m. to 3:30 p.m.
CPUC Courtyard Room | 505 Van Ness Avenue | San Francisco

WORKSHOP AGENDA

10:00- 10:15 a.m. Welcome and Introductions

10:15- Noon Joint-Utility Straw Proposal for New California Standards for Electric Distribution
Asset Physical Security Plan Review, Adoption, and Maintenance

Presentations by the utilities, followed by Q&A

Spotlight on select issues:

1. Security plan review and approval
2. Balancing accounts v. GRCs
3. Sensitive information – D. 16-08-024 confidentiality rules
 - o specifying categories of potential “unaffiliated third parties”
 - o defining “security-sensitive” information
4. Essential customers, and consideration of trauma centers and nursing homes
5. Commission jurisdiction and POU

Noon- 1:15 p.m. **L U N C H – one hour, 15 minutes**

1:15- 2:00 p.m. Physical Security Plan Consultant Services | Minimum Qualifications for

Establishing Third-party Reviewer Competency

Group discussion with SED and utility staff

2:00 p.m. *Break* – 10 minutes

2:10- 2:50 p.m. Physical Security Proceeding Scoping Memo Recap and SB 699 Directives
Recap and Retrospective

A consensus-seeking exercise led by SED staff to recount those items originally believed to have been valid, applicable, and timely and to determine if circumstances have changed such that certain items are now considered as non-essential, and to tally any items not addressed thus far

2:50- 3:30 p.m. SED Staff White Paper on Physical Security Plan Update and Overview

Presentation by SED staff, followed by Q&A

3:30 p.m. **A D J O U R N**

APPENDIX 4 | SB 699 AS CHAPTERED:

Approved by Governor September 25, 2014. Filed with Secretary of State September 25, 2014.

LEGISLATIVE COUNSEL'S DIGEST

SB 699, Hill. Public utilities: electrical corporations.

Under existing law, the Public Utilities Commission has regulatory authority over public utilities, including electrical corporations, as defined. Existing law requires the commission to adopt inspection, maintenance, repair, and replacement standards for the distribution systems of electrical corporations in order to provide high-quality, safe, and reliable service. Existing law requires the commission to conduct a review to determine whether the standards have been met and to perform the review after every major outage.

This bill would require the commission, in a new proceeding, or new phase of an existing proceeding, to commence on or before July 1, 2015, to consider adopting rules to address physical security risks to the distribution systems of electrical corporations.

Under existing law, a violation of the Public Utilities Act or any order, decision, rule, direction, demand, or requirement of the commission is a crime.

Because the provisions of this bill are within the act and require action by the commission to implement its requirements, a violation of these provisions would impose a state-mandated local program by expanding the definition of a crime.

The California Constitution requires the state to reimburse local agencies and school districts for certain costs mandated by the state. Statutory provisions establish procedures for making that reimbursement.

This bill would provide that no reimbursement is required by this act for a specified reason.

California Public Utilities Commission | Safety and Enforcement Division**BILL TEXT**

THE PEOPLE OF THE STATE OF CALIFORNIA DO ENACT AS FOLLOWS:

SECTION 1.

The Legislature finds and declares all of the following:

- (a) Physical threats to the electrical distribution system present risks to public health and safety and could disrupt economic activity in California.
- (b) Ensuring appropriate actions are taken to protect and secure vulnerable electrical distribution system assets from physical threats that could disrupt safe and reliable electric service, or disrupt essential public services, including safe drinking water supplies, are in the public interest.
- (c) Proper planning, in coordination with the appropriate federal and state regulatory and law enforcement authorities, will help prepare for attacks on the electrical distribution system and thereby help reduce the potential consequences of such attacks.

SEC. 2.

Section 364 of the Public Utilities Code is amended to read:

- (a) The commission shall adopt inspection, maintenance, repair, and replacement standards, and shall, in a new proceeding, or new phase of an existing proceeding, to commence on or before July 1, 2015, consider adopting rules to address the physical security risks to the distribution systems of electrical corporations. The standards or rules, which shall be prescriptive or performance based, or both, and may be based on risk management, as appropriate, for each substantial type of distribution equipment or facility, shall provide for high-quality, safe, and reliable service.
- (b) In setting its standards or rules, the commission shall consider: cost, local geography and weather, applicable codes, potential physical security risks, national electric industry practices, sound engineering judgment, and experience. The commission shall also adopt standards for operation, reliability, and safety during periods of emergency and disaster. The commission shall require each electrical corporation to report annually on its compliance with the standards or rules. Except as provided in subdivision (d), that report shall be made available to the public.
- (c) The commission shall conduct a review to determine whether the standards or rules prescribed in this section have been met. If the commission finds that the standards or rules have not been met, the

California Public Utilities Commission | Safety and Enforcement Division

commission may order appropriate sanctions, including penalties in the form of rate reductions or monetary fines. The review shall be performed after every major outage. Any money collected pursuant to this subdivision shall be used to offset funding for the California Alternative Rates for Energy Program.

(d) The commission may, consistent with other provisions of law, withhold from the public information generated or obtained pursuant to this section that it deems would pose a security threat to the public if disclosed.

SEC. 3.

No reimbursement is required by this act pursuant to Section 6 of Article XIII B of the California Constitution because the only costs that may be incurred by a local agency or school district will be incurred because this act creates a new crime or infraction, eliminates a crime or infraction, or changes the penalty for a crime or infraction, within the meaning of Section 17556 of the Government Code, or changes the definition of a crime within the meaning of Section 6 of Article XIII B of the California Constitution.

###

From: [Sandra Waldstein](#)
To: [David Morenoff](#); [Joseph McClelland](#); [Anna Cochrane](#); [Jignasa Gadani](#); [Andrew Dodge](#); [Larry Parkinson](#); [Richard O'Neill](#)
Cc: [John Peschke](#); [Jehmal Hudson](#); (b) (6)
Subject: Energy Transition Forum - Nov. 28th
Date: Tuesday, November 13, 2018 2:00:00 PM
Attachments: [Email to FERC Speakers.docx](#)
[FINAL Programme ETF November 2018.pdf](#)
[FINAL Biographies ETF November 2018.pdf](#)

Greetings,

You have all agreed to participate in the Energy Transition Forum here at FERC on Wednesday, November 28th. Attached you will find an email from the Energy Transition Forum team, thanking each of you for attending. Also attached is an updated agenda and a list of attendees with biographies.

As for logistics, we will meet in the Commission meeting room. We'll do our best to stick to the time frames in the agenda so please plan your remarks accordingly, leaving plenty of time for questions and discussions. If you wish to use power points it would be helpful to get those to me by COB Monday, Nov. 26th as we will make printed copies for the participants. If you have questions about the content of your remarks you may want to reach out to John Jimison whose contact information is included in the attached email.

There will be a coffee break mid-afternoon that will be held in the Portrait Gallery and catered by an outside company. You have all been invited to join the Forum participants for a reception and dinner Wednesday evening at the Metropolitan Club. The following speakers have sent in their RSVP: Larry Parkinson, Andy Dodge, Joe McClelland, Dick O'Neil, and Sandie Waldstein. If anyone else wishes to attend please let me know. GAL has approved our attendance.

Please let me know if you have any questions and thanks for agreeing to participate.

Sandie

Sandra Waldstein
Director, Division of State, International & Public Affairs
Office of External Affairs
Federal Energy Regulatory Commission
202-502-8092
sandra.waldstein@ferc.gov



To: Sandra Waldstein
David Morenoff
Joe McClelland
Anna Cochrane
Jignasa Gadani
Richard O'Neill
Andrew Dodge
Larry Parkinson

From: John Jimison
On behalf of the Energy Transition Forum Organizing Committee

Date: November 6, 2018

Re: Energy Transition Forum visit to FERC, November 28th

My fellow organizers and I are very much looking forward to your part in the Energy Transition Forum (ETF) in Washington, DC, as our 36 distinguished participants visit FERC on the afternoon of Wednesday, November 28th. Please find attached the ETF Programme and Participants List, including the Biographies of all participants and speakers. Further changes are possible, and you will receive hard copies of both documents as finalized in the room where the ETF session at FERC takes place.

Please note the order indicated in the programme to help you time your own appearance, but recognize that you are welcome to attend the entire session and to mingle with our participants at the scheduled coffee break. It is also worth noting that while all our European and Asian participants are fully functional in English, speaking distinctly and deliberately will enhance everyone's ability to fully understand your comments on these sophisticated and sometimes technical subjects.

If you have any logistical questions, please reach out to Kevin Head, Programme Associate, ETF at pa@foreseeltd.co.uk or on his mobile number (+1 303 859 5444). For any substantive questions, don't hesitate to reach me at 202-536-8971.

We are very much looking forward to launching our 2018 ETF US workshop with our visit to FERC. As you will see in the programme, our intensive discussion during the following two days focuses on the salient issues that we are asking you to help us understand through your thoughts and expertise.

The Energy Transition Forum Team

Miriam Maes, Chair, Energy Transition Forum; Chairman, Supervisory Board, Port of Rotterdam, UK
Christophe Brognaux, Senior Partner and Managing Director, The Boston Consulting Group, Belgium
Reid Detchon, Senior Advisor for Climate Solutions, United Nations Foundation, USA
John Jimison, Executive Director, Americans for a Clean Energy Grid, USA
Gerard Reid, Co-Founder & Partner, Alexa Capital, UK
Kevin Head, Programme Associate, Energy Transition Forum, UK



Energy Transition Forum Participants

28-30 November 2018, Washington, DC

US Utilities

- **Kathleen Barrón**, Senior Vice President, Government and Regulatory Affairs and Public Policy, Exelon Corporation; former Deputy General Counsel, FERC, USA
- **John DiStasio**, President and CEO, Large Public Power Council; former General Manager, Sacramento Municipal Utility District, USA
- **Pat Hogan**, Senior Vice President of Electric Operations, Pacific Gas and Electric Company, USA
- **Martin Lowery**, Executive Vice President, National Rural Electric Cooperative Association, USA
- **Phil Moeller**, Executive Vice President, Business Operations Group and Regulatory Affairs, Edison Electric Institute; former Commissioner, Federal Energy Regulatory Commission, USA
- **Andy Ott**, President and CEO, PJM Interconnection, USA
- **Stephen Prince**, CEO, Centrica Business Solutions North America, USA
- **Eric Schmitt**, VP of Operations, California Independent System Operator, USA
- **Gordon van Welie**, President and CEO, New England Independent System Operator, USA
- **Rudy Wynter**, President & COO - Transmission, Generation and Energy Procurement National Grid US, USA

Utilities, Other Regions

- **Suleman Alli**, Director, Strategy & Regulation, UK Power Networks, UK
- **Bente Hagem**, Board Chair, ENTSO-E (European Network of Transmission System Operators); Executive Vice President for European Affairs, Statnett, Norway
- **Rajiv Mishra**, Managing Director India, China Light and Power, India
- **Derek Parkin**, Chief Operating Officer, China Light and Power, Hong Kong
- **Fintan Slye**, CEO, UK System Operator, National Grid, UK; former CEO, EirGrid, Ireland

IT, Technology and New Energy Companies

- **Stephen Callahan**, Vice President of Global Strategy and Solutions for the Energy & Utilities Industry, IBM, USA
- **Gregg Rotenberg**, CEO, Smart Wires (transmission management solutions), USA
- **Harald Schrimpf**, Chairman, PSI Software (software solutions for utilities and industry incl. energy management systems), Germany
- **Michael Walsh**, Managing Director Europe, Smart Wires (transmission management solutions), UK
- **Felix Zhang**, Group Executive Director and Venture Partner, Envision Energy (renewable energy), China/USA

Other Industry, Finance and Professional Services

- **Tom Baker**, Partner and Managing Director, Global Topic Leader, Distributed Energy Resources, Boston Consulting Group, USA
- **Mike French**, VP, Government Affairs and Public Relations, Orano USA, USA
- **Pierre Germain**, VP, Washington Representative Office, Total, USA/France
- **Chad Holliday**, Chairman of the Board, Royal Dutch Shell, Netherlands
- **John Lynch**, Managing Director for Principal Investments, J.P. Morgan Asset Management - Infrastructure Investments Group, UK
- **Armin Schnettler**, Senior VP, Research in Energy and Electronics, Siemens, Germany

Government Authorities

- **Jens Acker**, Counselor, Energy Trade, Digital Economy, Embassy of the Federal Republic of Germany, Germany
- **Dominique Jamme**, Advisor to the President, French Regulatory Commission (CRE), France
- **Richard Kauffman**, Chairman of Energy Policy and Finance, Office of the Governor, State of New York, USA
- **Melanie Kenderdine**, Principal, Energy Futures Initiative; former Director, Energy Policy and Systems Analysis and Energy Counselor to Secretary Moniz, Department of Energy, USA
- **Gerassimos Thomas**, Deputy Director General for Energy, European Commission, Belgium
- **Jon Wellinghoff**, CEO, GridPolicy Consulting; former Chairman, FERC, USA

NGOs

- **Sonia Aggarwal**, Vice President, Energy Innovation Policy & Technology, LLC, USA
- **Mark Brownstein**, Senior Vice President of Energy, Environmental Defense Fund, USA
- **Matt Futch**, Global Strategy and Business Development Director, NREL, USA
- **Mike Howard**, President and CEO, Electric Power Research Institute, USA
- **Peter Ogden**, Vice President, United Nations Foundation, USA
- **Rich Powell**, Executive Director, ClearPath Energy Action, USA

- **Barbara Tyran**, Executive Director, Government & External Relations, Electric Power Research Institute, USA

Speakers on Capitol Hill

- **Rep. Carlos Curbelo (R., Florida)**, Chair of the Congressional Climate Solutions Caucus, US House of Representatives, USA (Invited)
- **Kellie Donnelly**, Senior Counsel, Senate Energy & Natural Resources Committee, Majority Staff
- **Sam Fowler**, Chief Counsel, Senate Energy & Natural Resources Committee, Minority Staff (Invited)
- **Rick Kessler**, Senior Adviser, House Energy & Commerce Committee, Minority Staff
- **Sen. Ed Markey (D., Massachusetts)**, United States Senate, USA (Invited)
- **Annelise Rickert**, Senior Counsel, House Energy & Commerce Committee, Majority Staff
- **Rep. Peter Welch (D., Vermont)**, Member of the Congressional Climate Solutions Caucus, US House of Representatives, USA (Invited)

Speakers at Federal Energy Regulatory Commission

- **Anna Cochrane**, Director, Office of Market Regulation, FERC, USA
- **Andrew Dodge**, Director, Office of Electric Reliability, FERC, USA
- **Jignasa Gadani**, Acting Director, Office of Energy Policy and Innovation, FERC, USA
- **Joe McClelland**, Director, Office of Energy Infrastructure Security, FERC, USA
- **David Morenoff**, Deputy General Counsel, FERC, USA
- **Richard O'Neill**, Chief Economic Advisor, FERC, USA
- **Larry Parkinson**, Director, Office of Enforcement, FERC, USA
- **Sandra Waldstein**, Director, Division of State, International and Public Affairs, FERC, USA

Speakers at the Energy Transition Forum

- **Nadya Bartol**, Associate Director, BCG Platinion, USA
- **Michael Coden**, Managing Director, Head of Cybersecurity Practice, BCG Platinion, USA
- **Karen Evans**, Assistant Secretary for the Office of Cybersecurity, Energy Security, and Emergency Response, US Department of Energy, USA (Invited)
- **Vic Fazio**, Senior Advisor, Akin Gump; Former Congressman (CA), US Congress
- **Geoffrey Garin**, President, Hart Research, USA
- **Richard Glick**, Commissioner, FERC, USA
- **Rachel Kyte**, Chief Executive Officer, Sustainable Energy for All; Special Representative of the United Nations Secretary-General, USA/Austria
- **Ernest Moniz**, Former US Secretary of Energy; Professor of Physics, MIT; President & CEO, Energy Futures Initiative, USA

- **Theresa Payton**, President and CEO, Fortalice Solutions; CIO, President George W. Bush Administration, USA
- **John Podesta**, Founding President, Center for American Progress; Former White House Chief of Staff and Counsellor, Presidents Obama and Clinton, USA
- **Don Santa**, President, Interstate Natural Gas Association; former Commissioner, FERC; former Senior Staff, Senate Energy Committee, USA
- **Jerry Taylor**, President, The Niskanen Center, USA
- **Rep. Fred Upton** (R., Michigan), Member of the Congressional Climate Solutions Caucus, US House of Representatives, USA (Invited)

Energy Transition Forum Team

- **Miriam Maes**, Chair, Energy Transition Forum; Chairman, Supervisory Board, Port of Rotterdam, UK
- **Christophe Brognaux**, Senior Partner and Managing Director, The Boston Consulting Group, Belgium
- **Reid Detchon**, Senior Advisor for Climate Solutions, United Nations Foundation, USA
- **John Jimison**, Executive Director, Americans for a Clean Energy Grid, USA
- **Gerard Reid**, Co-Founder & Partner, Alexa Capital, UK
- **Kevin Head**, Programme Associate, Energy Transition Forum, UK/USA

Jens Acker

Counselor, Energy Trade, Digital Economy, Embassy of the Federal Republic of Germany, Germany



Jens Acker studied law and joined the regional administration of the Land of Saxony in 2000, with responsibility for regional funding programs and later relations with the German federal state. Starting in 2007, he worked for the Federal Ministry for Economics and Energy. After Fukushima, he joined the German Energy Department, where he was concerned with security of supply issues and CHP. Since April 2016 he has been posted at the German Embassy in Washington DC, where he is responsible for energy and climate issues.

Sonia Aggarwal

Vice President, Energy Innovation Policy & Technology, LLC, USA



Sonia Aggarwal is the Vice President of Energy Innovation, where she leads the firm's work on Power Sector Transformation and Energy Policy Solutions. In 2012, Sonia spearheaded the creation of America's Power Plan, Energy Innovation's platform for innovative thinking on policy solutions for clean, reliable, and affordable electric power in the U.S. America's Power Plan produces and curates expert information for decision-makers—utility regulators, governors' staffs, power system operators, and many more—providing tailored advice on how to lead and support the transition to a decarbonized power system.

For Energy Policy Solutions, Sonia leads Energy Innovation's work in identifying and designing the top energy policies to reduce emissions. The program uses a computer model developed in-house, the Energy Policy Simulator, to quantify the cost and emissions impacts various combinations of climate and energy policies have within a region (so far, open source models have been released for Canada, China, India, Indonesia, Mexico, Poland, and the U.S.). In addition to the quantitative model, which helps to identify which policies can make the biggest impact, the Energy Policy Solutions program also provides tailored consultation to policymakers on how to design those policies for maximum effectiveness.

Before Energy Innovation, Sonia managed global research at ClimateWorks Foundation, worked on the McKinsey carbon abatement cost curves, advised the International Energy Agency's "Accelerating Technology Transitions" project, advised clean energy companies on technology and financial communications, and worked in accident prevention design engineering at a nuclear power plant. Sonia holds a B.S. from Haverford College in astronomy and physics, and an M.S. from Stanford University in engineering, focused on energy.

Suleman Alli

Director, Strategy & Regulation, UK Power Networks, UK



Suleman Alli joined UK Power Networks in May 2015 as Director of Safety, Strategy and Support Services. UK Power Networks is the country's biggest electricity distributor, serving more than eight million homes and businesses across London, the South East and the East of England.

Suleman is responsible for ensuring the safety, health and wellbeing of more than 6,000 employees. During his tenure to date, he has orchestrated the delivery of a new approach to safety initiatives, including a safety culture programme that has contributed to UK Power Networks becoming the safest

Distribution Network Operator in the UK.

Since 2015 Suleman has overseen the complete transformation of UK Power Networks' outdated IT systems and architecture in what was the biggest utility IT transformation change programme of its kind in Europe. Delivering a change programme of this scale and complexity during a period of year-on-year company performance improvement was recognised as a key factor in UK Power Networks achieving the accolade of Utility of the Year in 2016 for the second year in succession and third time since 2012.

Other responsibilities include leading the future energy and innovation agenda for UK Power Networks. This means ensuring that UK Power Networks is well placed to be able to influence and proactively respond at a time when the energy market in the UK moves away from a traditional model toward energy storage, distributed generation, digitalisation and smarter networks.

Previously Suleman was a Managing Director at Accenture, leading the utility network operations practice in the UK. He has 15 years of utilities experience, delivering business transformation, company restructures and operational performance improvement across gas, electricity and water sectors. He holds a BSc (Hons) in Accounting and Finance from the London School of Economics and Political Science.

Tom Baker

Partner and Managing Director, Global Topic Leader, Distributed Energy Resources, Boston Consulting Group, USA



Tom Baker is a core member of the Energy practice area and leads the renewable energy topic in North America. He is also BCG's global topic leader for distributed energy resources (DER), supporting utilities and developers across the US, Australia, Korea and Europe, and is author of several BCG perspectives on renewable energy topics.

During his time at BCG, he has focused on: developing a go-to-market plan for an international CCS company, evaluating the GHG impact of different ICT technology for a major trade organization, developing renewables market entry strategy for an international player, developing EV customer acquisition strategy for utility, evaluating the US market potential for battery storage (across different

geographies and use cases) and a client's technology and cost-structure for a battery storage OEM, developing a strategy for a major energy company to grow its North America utility-scale wind development and ownership, working with the energy service arm of a major oil & gas company to evaluate the strategy of its utility scale solar, battery developments and other clean-tech offerings, performing an overarching transformation of a US utility with a focus on integrating distributed generation and utility-scale renewables, building a modern grid, leveraging storage and creating new customer-focused products & services, and developing a strategy for a California utility on how to respond to distributed energy resources.

Prior to joining BCG, Tom worked in the strategic marketing department of First Solar, where he developed a go-to-market strategy for the US East Coast solar market and investigated new markets. He holds a Ph.D. in chemical physics from Harvard University, with a focus on computational solid-state physics applied to heterogeneous catalysis and PV.

Kathleen Barrón

Senior Vice President, Government and Regulatory Affairs and Public Policy, Exelon Corporation; former Deputy General Counsel, FERC, USA



Kathleen Barrón leads the development and implementation of federal, state and regional governmental, regulatory and public policy strategies for Exelon Corporation, the nation's largest producer and distributor of clean energy. She is responsible for identifying and assessing key federal and state policy issues of interest to Exelon, crafting the company's position on such issues, and developing strategies for achieving public policy objectives on behalf of Exelon's customers and businesses. She also is responsible for managing the company's wholesale market design advocacy in each of the regional markets where the company operates.

Prior to joining Exelon, she was the Deputy General Counsel at the Federal Energy Regulatory Commission (FERC), where she advised the Commission on all aspects of its responsibilities and represented the Commission before Congress, government agencies, and industry groups. Previously, she was the FERC's associate general counsel for energy markets, where she led a group of about 90 lawyers on legal and policy matters related to electric power sales and transportation, electric system reliability, corporate regulation of public utilities and natural gas and oil pipeline transportation. Prior to joining FERC, she was in private practice with the law firm Skadden, Arps, Slate, Meagher and Flom LLP. There, she represented utility and independent power producer clients in proceedings before FERC, U.S. Courts of Appeal, and state utility commissions.

Nadya Bartol

Associate Director, BCG Platinion, USA



Nadya Bartol is a globally recognized cybersecurity leader with a focus in the energy and utilities space. Currently working for BCG Platinion, she was formerly the Associate Head of Cybersecurity Practice in Bethesda, MD. She is a published author on topics across supply chain risk management, security measurement, and utilities cybersecurity.

Prior to joining BCG Platinion, Nadya worked as a Senior Associate at Booz Allen Hamilton, as Vice President of Industry Affairs, Cybersecurity Strategist at the Utilities Technology Council.

She holds a MS-MIS, Information Systems and MBA from Boston University.

Christophe Brognaux

Senior Partner and Managing Director, The Boston Consulting Group, Belgium



Christophe Brognaux is the leader of The Boston Consulting Group's energy practice in Western Europe, Africa and South America. He previously coordinated the power and gas sector globally within the practice.

Christophe has led more than 200 energy projects for integrated power and gas players, independent power producers (IPPs), regulated transmission and distribution system operators, gas wholesalers, new entrants, large energy consumers, OEMs, and private equity funds. He has also engaged with policy makers across Western Europe, Chile, Russia, China, and the United States. This experience has allowed him to develop a broad understanding

of power and gas markets and potential business models for industry players.

Christophe is the author of several articles on market design and regulation. He is a frequent speaker at conferences and regularly interacts with policy makers as well as industry associations.

Before joining BCG in 1996, Christophe headed a process-engineering team at L'Oréal.

Mark Brownstein

Senior Vice President of Energy, Environmental Defense Fund, USA



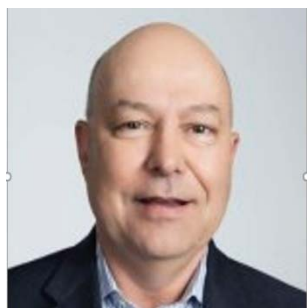
Mark Brownstein is Senior Vice President of Energy at Environmental Defense Fund, and a member of EDF's executive team. He leads the organization's work on electricity, oil and gas, and transportation. The goal of the program is to deliver tangible environmental and public health gains while accelerating the energy sector's transition to a low carbon future.

Mark is a member of the Electric Power Research Institute's Public Advisory Board and the University of Pennsylvania's Kleinman Center for Energy Policy Advisory Board, and the National Petroleum Council.

He is an adjunct professor of law at New York University Law School where he co-teaches a seminar on public policy and energy project finance. Mark has also taught energy policy at Columbia University's School of International and Public Affairs (SIPA).

Stephen Callahan

Vice President of Global Strategy and Solutions for the Energy & Utilities Industry, IBM, USA



Stephen J. Callahan is IBM's Vice President of Global Strategy and Solutions for the Energy & Utilities industry and an IBM Industry Academy member. Over his 30-plus year career in industry management and in consulting he has led the development of business and technical strategy and implemented complex processes and systems spanning T&D and customer operations, finance, network and the smart grid.

Prior to his current position, he was for 15 years a Partner for Coopers & Lybrand, PwC and IBM (via successive acquisitions) focused on electric utility restructuring and industry business and technology strategy. He has led numerous large complex process and system implementations and was the lead partner for the implementation of the California ISO and the lead US partner for the IMO in the Province of Ontario, Canada. He led the creation of the utility e-procurement consortium Pantellos and was a pioneer in the large-scale deployment of AMI technology.

Prior to IBM, Steve held various management positions over a span of 15 years at Pacific Gas and Electric (PG&E) Company in San Francisco in the areas of commercial and industrial energy management, telecommunications network planning, and financial systems. He holds degrees in both Applied Physics and Mechanical Engineering from the Georgia Institute of Technology and is a registered Professional Engineer and Certified Energy Auditor.

Anna Cochran

Director, Office of Market Regulation, FERC, USA



Anna V. Cochran is the Director of the Office of Energy Market Regulation, having also served as Deputy from May 2009 until June 2017. She has over 35 years of experience in the energy industry, having worked both in private industry and at the Commission. She has held a number of managerial positions of increasing responsibility including Deputy Director of the Office of Enforcement and Director of the East Division of OEMR. OEMR deals with matters involving energy markets, tariffs and rates relating to electric, natural gas, and oil pipeline facilities and services.

OEMR serves the public interest by ensuring just and reasonable rates, tariffs and conditions in natural gas pipeline, oil pipeline and electric power markets. She holds a bachelor's degree in International Economics from Georgetown University School of Foreign Service.

Michael Coden

Managing Director, Head of Cybersecurity Practice, BCG Platinion, The Boston Consulting Group, USA



Michael Coden is Managing Director and Head of the Cyber Security Practice at BCG Platinion, the Boston Consulting Group. He is also co-founder and Associate Director, of the MIT Interdisciplinary Consortium for Improving Critical Infrastructure Cybersecurity, or MIT-(IC)³. In addition, he serves as Editor of the ISA99/IEC-62443 Cybersecurity Technical Report and Standard, as well as Cybersecurity Advisor to SenaHill Partners, a venture capital and merchant bank. He was involved in the USA NIST Cybersecurity Framework process and received a letter of appreciation from the White House for his leadership.

Previously Michael was Vice President of NextNine Inc., where he was instrumental in creating and leading the execution of NextNine's cyber security product and business strategy. He also created and managed the global partnerships with NextNine's largest strategic customers, almost two dozen companies in the Fortune Global 1000, on five continents.

Michael began his career at HP, DEC, Maher Terminals and ExxonMobil. Afterwards, he was founder and CEO of Codenoll, eventually purchased by ADC Telecommunications, and where he remained as Vice President of Marketing and CTO for Digital Broadband Communications. Later, he founded Magjic LLC and consulted for several high-technology companies and venture-capital firms.

Recipient of several industry awards, an (ISC)² Certified Information Systems Security Professional (CISSP), Michael earned his Bachelor's in Electrical Engineering at MIT, his Master's in Business Administration from Columbia University, as well as a second Master's in Mathematics from NYU's Courant Institute of Mathematical Sciences.

Rep. Carlos Curbelo (R., Florida)

**Chair of the Congressional Climate Solutions Caucus, US House of Representatives, USA
(Invited)**



Carlos Curbelo is the U.S. representative for Florida's 26th congressional district, elected in 2014. In addition to sitting on the House Committee on Ways and Means, he is Co-Chair of the Climate Solutions Caucus. This Caucus serves as an organization to educate House members on economically viable options to reduce climate risk and protect the economy, security, infrastructure, agriculture, water supply and public safety of the U.S.

He attended the University of Miami, where he earned bachelor's and master's degrees in public administration.

Reid Detchon

Senior Advisor for Climate Solutions, United Nations Foundation, USA



Reid Detchon is Senior Advisor for Climate Solutions at the United Nations Foundation. He previously served as the Foundation's Vice President for Energy and Climate Strategy from 2006 to 2017. He also served as Executive Director of the Energy Future Coalition, a non-partisan domestic policy initiative.

The Foundation's engagement with the UN on energy and climate issues has included communications support for the IPCC's Fifth Assessment Report and special report on the impacts of global warming of 1.5 °C. Other activities include support of the Secretary-General's initiative on Sustainable Energy for All – whose objectives are now reflected in Goal 7 of the new post-2015 Sustainable Development Goals.

Reid previously served as the Principal Deputy Assistant Secretary for Conservation and Renewable Energy at the U.S. Department of Energy from 1989 to 1993; as principal speechwriter for Vice President George H. W. Bush; and as a staff member and legislative director for U.S. Senator John Danforth of Missouri.

John DiStasio

President and CEO, Large Public Power Council; former General Manager, Sacramento Municipal Utility District, USA



John Di Stasio joined the Large Public Power Council (LPPC) in August 2014. The LPPC represents the 26 largest consumer-owned utilities in the United States. He serves as the Association's President, based in Washington, DC, representing the interests of the member organizations.

John was formerly the General Manager and CEO of the Sacramento Municipal Utility District (SMUD) from June of 2008 through April of 2014. He joined SMUD in 1981, serving in progressively responsible positions including the Director of Distribution Services and Assistant General Manager of Energy Delivery and Customer Services. Prior to his appointment as CEO, he was responsible for all retail aspects of SMUD.

John is the past president of both the Northwest Public Power Association and the California Municipal Utility Association and the vice chair of the Large Public Power Council. He was also a board member of the Business Council for Sustainable Energy and the American Public Power Association. He was a member of the North American Electric Reliability Corporation's Members Representative Committee. He was also a gubernatorial appointee to the California Workforce Investment Board. He was the Electric Light and Power Large Utility CEO of the Year in 2013.

John is also active in international energy issues, serving as a delegate with the United States Energy Association, where he assisted in electrification, operations and energy market development in other countries including Bangladesh, Brazil, Botswana, India and Jordan.

Andrew Dodge

Director, Office of Electric Reliability, FERC, USA

Andy Dodge is the Director of the Office of Electric Reliability (OER). Previously, Andy served as an Electrical Engineer in the Office of Energy Infrastructure Security (OEIS).

Andy has over 30 years of industry and regulatory experience as a proven executive leader and electrical power engineer in all aspects of electric transmission and distribution utilities. Prior to joining the Commission, he served as the Chief Engineer (Director, Engineering Division) for the Maryland Public Service Commission. In addition, he served as Vice President for Technical Services, Vice President for Electric System Operations and Planning, Vice President for Transmission Operations and Planning, and Vice President for Distribution Operations and Planning for Baltimore Gas and Electric (BGE). Andy has extensive experience in transmission & distribution system planning and operations, emergency preparedness and storm restoration activities, NERC Reliability Standards Compliance (the Order No. 693 and CIP Standards), regulatory compliance activities, project management, and program management.

Andy earned a bachelor's degree with honors in electrical engineering from the University of Maryland College Park, and a master's degree in electrical engineering from George Washington University. He is also a registered professional engineer in Maryland.

Kellie Donnelly

Senior Counsel, Senate Energy & Natural Resources Committee, Majority Staff



Kellie Donnelly joined the Committee on Energy and Natural Resources of the United States Senate in 2003 and serves as the Deputy Chief Counsel. In this position, she provides counsel on all energy policy and federal land management issues within the Committee's vast jurisdiction. She has a particular focus on electricity, cybersecurity and renewable energy issues.

Prior to serving on the Committee, Kellie was an attorney with Sullivan & Worcester, LLP (previously affiliated with Verner Liipfert). In this capacity, she represented municipal utilities, rural electric cooperatives, and investor-owned utilities before the Federal Energy Regulatory Commission, state regulatory commissions, and U.S. Courts. Her practice also included assisting clients with resource issues such as hazardous waste, water rights, and endangered species.

Previously, Kellie worked as a Counsel at the U.S. Department of the Interior. She also served as Counsel to the U.S. Senate Committee on Environment and Public Works. She holds a J.D. from the Columbus School of Law, Catholic University of America and a B.A. from The College of the Holy Cross. She was selected as a Congressional Stennis Fellow for the 110th Congress.

Karen Evans

Assistant Secretary for the Office of Cybersecurity, Energy Security, and Emergency Response, US Department of Energy, USA (Invited)



Karen Evans is the first assistant secretary of the Energy Department's Office of Cybersecurity, Energy Security and Emergency Response. Before being nominated by President Trump to lead the Department's cybersecurity efforts, she served in the public sector as a top IT official at the Office of Management and Budget under President George W. Bush, in the position that is now known as the federal CIO. She has also previously served as DOE's CIO.

Most recently, she was the National Director of the U.S. Cyber Challenge, a public-private program designed to help address a skills gap in the cybersecurity field. She received her MBA and BA in Chemistry from West Virginia University.

Vic Fazio

Former Congressman; Senior Advisor, Akin Gump



Vic Fazio served for 20 years as a member of Congress, representing California's 3rd District. During his tenure of distinguished public service, he was appointed to the House Appropriations Committee, serving as a subcommittee chairman or ranking member for 18 years. He was also a member of the Armed Services, Budget, Ethics and House Administration committees.

Before his election to Congress, he served in the California State Assembly. Prior to being elected to public office, he was a senior assistant to the speaker of the California Assembly.

After his retirement from Congress in 1998, Vic served as the co-managing partner of strategic communications consulting firm Clark & Weinstock in Washington. He is a graduate of Union College in Schenectady, New York, and served as a CORO Foundation Fellow in California upon graduation. He has a significant background in journalism and co-founded the California Journal, a periodical covering state government and politics.

Sam Fowler

Chief Counsel, Senate Energy & Natural Resources Committee, Minority Staff (Invited)



Sam Fowler is the Chief Counsel for the Democratic minority on the Senate Energy & Natural Resources Committee.

He has served with the Smithsonian Institution, the Council on Environmental Quality, in private practice and with Mo Udall in the House of Representatives. Sam joined the staff of the Committee in 1991.

He is a graduate of the University of New Hampshire and the George Washington University Law School.

Mike French

VP, Government Affairs and Public Relations, Orano USA, USA

Mike French is the Vice President of Government Affairs and Public Relations for Orano USA, formerly Areva. Orano is a French multinational group specializing in nuclear power and renewable energy, headquartered in Paris. Prior to his current role, French served as VP Strategy and Customer Relations for AREVA Federal Services, Director Media Relations for AREVA Inc., and Sr Policy Advisor for AREVA Enrichment Services, LLC.

Mike received his degree from the University of Maryland.

Matt Futch

Global Strategy and Business Development Director, National Renewable Energy Laboratory (NREL), USA



Matt serves as the strategy and business development leader for the National Renewable Energy Laboratory. His work focuses on aligning the research priorities with critical industry partners to formulate scientifically valid projects with long term commercial value.

Matt has successfully developed regulatory and utility business strategies for a diversity of projects, captured large revenue streams across global operating geographies. Most recently, as VP of Regulatory Strategy for

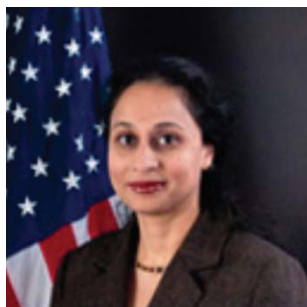
National Grid US, Matt led the development of a long-term regulatory and business strategy for three jurisdictional companies across New York, Massachusetts, and Rhode Island, along with corporate-wide policy on key energy issues involving security, data privacy and distributed generation.

Previously, as Global Policy Director for the IBM Corporation, Matt directed a corporate-wide program on energy regulation, policy and business climate for all IBM international growth energy markets in the ASEAN region, Middle East and Africa, Australia, Brazil, the EU and North America. He spearheaded approvals of regulators and final client signature for major system integration and software / services deals totaling over \$150M.

Earlier in his career, Matt provided leadership for energy policy at the Colorado Governor's Energy Office while working with the State's electric and gas power sector. He helped negotiate and craft the clean energy policies of Governors Bill Ritter, Jr. and John W. Hickenlooper including the passage of numerous renewable energy, smart grid, and energy efficiency bills. Matt holds a Master of Arts in Global Finance and International Trade from the University of Denver and a Bachelor of Arts in Communications from Colorado State University. He lives with his family in Denver, Colorado.

Jignasa Gadani

Acting Director, Office of Energy Policy and Innovation



Jignasa Gadani is the Acting Director of the Office of Energy Policy and Innovation at the Federal Energy Regulatory Commission.

Prior to joining the Office of Energy Policy and Innovation, she served from 2010-2014 as the Director of the East Division in FERC's Office of Energy Market Regulation. She has held several other positions at the Commission, including as an attorney advisor in the Office of the General Counsel's Energy Markets Division from 2001-2006 and 2009-2010, and as a Legal Advisor to Commissioner Philip D. Moeller from 2006-2009. During law

school, she also worked at the Illinois Commerce Commission.

She earned a B.A. from DePaul University and a J.D., with a Certificate in Environmental and Energy Law, from Chicago-Kent College of Law, Illinois Institute of Technology.

Geoff Garin

President, Hart Research



Geoffrey Garin became president of Hart Research in 1984, after having worked in the firm since 1978 as a senior analyst and vice president. He has undertaken landmark policy and communications research for many of the nation's leading foundations and educational institutions on topics that include global health and development, school reform, college affordability, healthcare reform, and global climate change. His clients for this research include the Bill & Melinda Gates Foundation, the MacArthur Foundation, Harvard University, and the College Board.

Geoff is a graduate of Harvard College.

Pierre Germain

Vice President, Washington Representative Office, Total, USA/France



Pierre Germain is a Vice President at Total's Washington Representative Office. Prior to this, he served as VP Business Development & Strategy at Total E&P USA, E&P Project Director at Total (France) and Head of the Subsurface & Petroleum Engineering Department at Sincor (now Petrocedeno).

He has received a Master's degree in Field Development from Ecole du Pétrole et des Moteurs and a Diploma of Engineer, Physics from ESPCI Paris Tech (Physique Chimie Paris).

Richard Glick

Commissioner, Federal Energy Regulatory Commission



Richard Glick has served on the Commission since November 2, 2017. Previously, he was general counsel for the Democrats on the Senate Energy and Natural Resources Committee. Rich was vice president of government affairs for Iberdrola's renewable energy, electric and gas utility, and natural gas storage businesses in the United States, and previously served as a director of government affairs for PPM Energy and director of government affairs for PacifiCorp. He served as a senior policy advisor to U.S. Energy Secretary Bill Richardson, and before that was legislative director and chief counsel to U.S. Senator Dale Bumpers of Arkansas.

Bente Hagem

Board Chair, ENTSO-E (European Network of Transmission System Operators); Executive Vice President for European Affairs, Statnett, Norway



Bente Hagem is Executive Vice President in Statnett SF responsible for European Affairs and Chair of the Board of ENTSO-E since 2015. Until 2014 she was head of Commercial Division in Statnett, responsible for market design, customer satisfaction, and settlement of grid services and wholesale market in Norway and the business development of cable projects to Denmark, UK and Germany.

She has been active in Nordic and European TSO cooperation since 2001, and was Co-Chair of the North West and South West European Market Coupling Project, when the coupling was realized. Now the daily coupling covers 80% of Europe and is probably the world largest physical electricity market, with 1500 TWh in yearly turnover.

Previously, she was Vice President of Statoil ASA for 10 years, working with natural gas and electricity. She has been a board member of several Norwegian companies and Chairman of Nord Pool Spot AS. She holds a Master Degree in Industrial Economy from the Norwegian University of Life Sciences.

Kevin Head

Programme Associate, Energy Transition Forum, UK/USA



Kevin Head is the Programme Associate at the Energy Transition Forum. He is currently pursuing an MSc in Environmental Economics and Climate Change at the London School of Economics and Political Science (LSE). After receiving his MSc in Accounting at the University of Colorado – Boulder, Kevin spent 5 years working for KPMG LLP as an external auditor in New York City and Denver, Colorado.

Kevin's interests in energy stem from the paradox of its integral role in the modern economy yet being the largest single driver of carbon emissions. He views the energy transition as both a difficult challenge and an exciting opportunity particularly regarding technological innovation, lowering air pollution, and encouraging job creation. He is expected to graduate from LSE in December 2018 and is currently based in London.

Pat Hogan

Senior Vice President of Electric Operations, Pacific Gas and Electric Company, USA



Patrick M. Hogan is Senior Vice President of Electric Operations at Pacific Gas and Electric Company, where he oversees PG&E's electric system, which delivers safe and reliable energy to more than 16 million people throughout Northern and Central California. In addition to his electric responsibilities, he has enterprise-wide responsibility for PG&E's Transportation Services, managing over 14,000 vehicles and pieces of equipment.

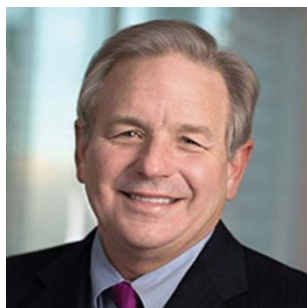
Prior to his current role, Pat served as Vice President of Electric Strategy & Asset Management, where he oversaw the company's electric transmission and distribution assets. He also led the development and deployment of technology into PG&E's electric system.

Before joining PG&E in 2013, Pat held leadership and officer roles in transmission, distribution, operations, engineering and asset management at British Columbia Hydro, National Grid, and KeySpan.

Originally from New York, he holds a bachelor's and master's degree in electrical engineering from Manhattan College and a master's degree in business administration from Hofstra University. His community involvement includes serving on the board of the San Francisco Ballet.

Chad Holliday

Chairman of the Board, Royal Dutch Shell, Netherlands



Charles O. (Chad) Holliday, Jr., was elected Chairman of Royal Dutch Shell in May 2015, having previously served as a Non-Executive Director since 2010. He is also currently a Director for Deere & Company and Hospital Corporation of America (HCA). He is a licensed Professional Engineer, and a member of the US Academy of Engineering and the UK Royal Society of Engineering.

He is a founding member of the International Business Council and an Advisor to the US Department of Energy. He has previously served as Chairman of the US Council on Competitiveness, the US National Academy of Engineering, the United Nations Sustainable Energy for All (SEforALL), the US Business Council, Catalyst, the Society of Chemical Industries (American Section), and the World Business Council for Sustainable Development.

Chad formerly served on the board of Bank of America Corporation for six years, and as Chairman from 2010 to 2014.

In his executive career, Chad was Chief Executive Officer of DuPont from 1998 to 2009, and Chairman from 1999 to 2009. He joined DuPont in 1970 and was initially responsible for various manufacturing and business assignments, including a six-year, Tokyo-based posting as President of DuPont APAC.

He has a BS in industrial engineering from the University of Tennessee and received honorary doctorates from Washington College in Chestertown, Maryland, the University of Tennessee, and the Polytechnic University of Brooklyn, New York.

Mike Howard

President and CEO, Electric Power Research Institute, USA



Michael W. Howard has more than 30 years of results-driven, multi-faceted leadership experience in organizations ranging from entrepreneurial start-ups to large public companies with increasing responsibilities in operations, finance, sales and marketing, product development, and strategic planning. Most of his experience is in providing technical consulting services and products to both U.S. and international electric utility companies.

Prior to his current appointment, Mike served as Senior Vice President, Research and Development, and President and Chief Executive Officer of EPRI Solutions, Inc., a wholly-owned subsidiary of EPRI. EPRI Solutions was created by the merger of three companies, one of which was the EPRI Power Electronics Application Center (PEAC) Corporation, where he served as President and Chief Executive Officer.

Previously, he was President of the Tennessee Center for Research and Development (TCRD) located in Knoxville, Tennessee, and President of Beta Development Corporation (BDC), an early-stage venture capital firm focused on providing equity investment in technology-based companies.

Mike began his career in 1980 with Westinghouse Electric Corporation as an applications engineer for the fossil and nuclear digital control systems group.

He holds a Bachelor of Science in electrical engineering from the University of Tennessee, a Master of Science in business and engineering management from the University of Pittsburgh, and a doctorate in engineering science from the University of Tennessee. He has also completed the MIT Reactor Technology Course.

Dominique Jamme

Advisor to the President, French Regulatory Commission (CRE), France



Dominique Jamme has been special advisor at CRE, the French energy regulatory commission, since May 2017. Prior to that, he was CRE's director for networks, working in particular on networks tariffs, market design, balancing, investment in interconnections, smart grids. He has 15 years of experience in market design and regulation of gas and electricity markets.

He is a graduate of Ecole Polytechnique Paris and ENSTA Paristech.

John Jimison

Executive Director, Americans for a Clean Energy Grid, USA



John Jimison is Executive Director of Americans for a Clean Energy Grid, engaged in building broad-based awareness of the need to expand, integrate and modernize America's high-voltage transmission system. He was previously Managing Director of the Energy Future Coalition.

From 2007 to 2011, John served as Senior Counsel to the Energy and Commerce Committee of the U.S. House of Representatives, responsible for energy efficiency, regulatory matters, energy markets, and electric grid modernization. He serves as General Counsel to both the International

Association for Energy Economics and the U.S. Association for Energy Economics, and as an Adjunct Professor of Energy Policy at the Johns Hopkins University.

John practiced law from 1987 through 2006 in Federal and state forums, specializing in natural gas regulation, cogeneration, and public utilities. From 1982 to 1985, he was Principal Administrator at the International Energy Agency in Paris, responsible for electricity and natural gas policy and analysis, as well as country expert for Spain and Australia. During the period from 1972 through 1981 he held several positions on Capitol Hill, including service as Counsel to the Energy and Commerce Committee, as Head of the Energy Section of the Congressional Research Service (Library of Congress), and as Professional Staff to the Senate Commerce Committee. He is a graduate of the College of Wooster and Georgetown University Law Center, a member of the Washington, D.C., and Virginia Bars, and a member of the Energy Bar Association.

Richard Kauffman

Chairman of Energy Policy and Finance, Office of the Governor, State of New York, USA



Richard Kauffman joined the office of Gov. Andrew Cuomo as the state's first Chairman of Energy and Finance for New York, or 'energy czar,' in January 2013. On behalf of Gov. Cuomo, he leads New York State's comprehensive energy policy effort, known as Reforming the Energy Vision (REV).

REV includes regulatory reform to modernize the energy and utility industry, a ten-year commitment to support renewable energy and efficiency markets through the \$5 billion Clean Energy Fund, and initiatives including the NY-Sun solar program and NY Green Bank. Through REV, New York State has enacted a Clean Energy Standard, mandating that 50 percent of the state's electricity must come from renewable sources by 2030. These efforts will help enable statewide greenhouse gas emission reductions of 40 percent by 2030.

Richard also oversees and manages the state's portfolio of energy agencies and authorities, comprised of the Department of Public Service (DPS), the New York Power Authority (NYPA), the Long Island Power Authority (LIPA), and the New York State Energy Research and Development Authority (NYSERDA). He was appointed chair of NYSERDA's board in June 2013.

As the state's most senior energy official, he was New York's lead delegate in Paris at the 2015 United Nations Climate Change Conference, or COP21. He was named by Fortune Magazine as one

of the World's Top 25 Eco-Innovators, and has received the Solar Champion Award from the Solar Energy Industries Association (SEIA) and Smart Electric Power Alliance (SEPA), the U.S. Green Building Council's Galvin Award for environmental leadership, and the Intersolar 2017 Champion of Change Award.

Prior to joining the Cuomo administration, Richard served as Senior Advisor to Secretary Steven Chu at the U.S. Department of Energy. In his private sector career, he was CEO of Good Energies, Inc., a leading investor in clean energy technologies, a partner of Goldman Sachs where he chaired the Global Financing Group, and vice chairman of Morgan Stanley's Institutional Securities Business and co-head of its Banking Department.

He has served as Chairman of the Board of Levi Strauss & Co., on the boards of the Brookings Institution and the Wildlife Conservation Society, and is a member of the Council on Foreign Relations. He received a bachelor's degree from Stanford University, a master's degree in international relations from Yale University, and a master's in public and private management from the Yale School of Management.

Melanie Kenderdine

Principal, Energy Futures Initiative, USA



Melanie Kenderdine is a Principal for EJM Associates. She is also a non-resident senior fellow at the Atlantic Council, a Washington think tank. She previously served at the Department of Energy from May 2013 to January 2017, as the Energy Counselor to Secretary Moniz and concurrently as the Director of DOE's Office of Energy Policy and Systems Analysis.

She wrote or edited two installments of the federal government's Quadrennial Energy Review, was a principal architect of the G-7 Energy Security Principles adopted in Brussels in 2014; and was the editor of the Energy Security Valuation Study, submitted to Congress in early 2017. In her capacity as energy counselor to Secretary Moniz, she provided key strategic advice on a broad range of issues across the Department of Energy.

Prior to her service at DOE, Melanie helped to establish the MIT Energy Initiative (MITEI) and served as its Executive Director. During her six-year tenure at MITEI, she was a member of the research team for MIT's Future of Natural Gas Study, was the rapporteur and editor for the MITEI Symposium Series, and edited the MIT Future of the Electric Grid study.

From 1993 to 2001, she was a political appointee in President Bill Clinton's administration, where she served in several key posts at DOE, including Senior Policy Advisor to the Secretary, Director of the Office of Policy, and Deputy Assistant Secretary for Congressional and Intergovernmental Affairs. Prior to joining DOE during the Clinton Administration, she was Chief of Staff and Legislative Director for New Mexico Congressman Bill Richardson, supporting his work on the House Committee on Energy and Commerce for six years.

In 2014, Melanie was named by the National Journal as one of the top five women in Washington shaping energy policy and is the longest-serving political appointee in the Department of Energy's 40-year history.

Rick Kessler

Senior Adviser, House Energy & Commerce Committee, Minority Staff



Rick Kessler is a public policy and political professional with over 20 years of experience in government and electoral politics at the federal, state and local levels. He is a frequent television, radio and print commentator on pipeline safety, energy, legislation and politics. As a government relations executive, he was named six years in a row to The Hill's Top Lobbyists list of "the most well-regarded industry advocates, major players and rising stars."

Prior to joining the Committee, Rick served as Senior Vice President at LEVICK, President and Partner at Dow Lohnes Government Strategies, as well as a number of other political roles. He holds degrees from Kenyon College and Rutgers University.

Rachel Kyte

Chief Executive Officer, Sustainable Energy for All; Special Representative of the United Nations Secretary-General, USA/Austria



Rachel Kyte is Chief Executive Officer of Sustainable Energy for All (SEforALL), and Special Representative of UN Secretary-General António Guterres for Sustainable Energy for All. She is a leading advocate for sustainable development and drives SEforALL's work to mobilize action towards its 2030 goals on universal energy access, energy efficiency and renewable energy. As SRSg, she is the UN's point person for the global Sustainable Development Goal on energy.

Until December 2015 Rachel served as World Bank Group Vice President and Special Envoy for Climate Change, leading integration of climate across the Bank Group's work as well as support for an ambitious agreement at the 21st Convention of the Parties of the UNFCCC (COP 21). She was previously World Bank Vice President for Sustainable Development and was the International Finance Corporation Vice President for Business Advisory Services.

A recipient of numerous awards for leadership on climate action and sustainable development, she is a Professor of Practice in Sustainable Development at Tufts' Fletcher School of Law and Diplomacy.

Martin Lowery

Executive Vice President, National Rural Electric Cooperative Association, USA



Martin Lowery is Chair of the National Cooperative Bank (NCB) and Executive Vice President, Emeritus, of the National Rural Electric Cooperative Association (NRECA). In May 2014 he was inducted into the Cooperative Hall of Fame, the highest honor that the U.S. cooperative community bestows on individuals who have made heroic contributions to the cooperative movement.

Martin is currently the elected U.S. representative to the board of the International Cooperative Alliance (ICA) and chairs the ICA Principles Committee as well as serving on the ICA Membership Committee. He is also the NRECA representative to the board of the U.S. Global Leadership Coalition, advocating for diplomacy and development as central to U.S. international affairs.

He received a Bachelor of Arts (cum laude) from DePaul University and a Ph.D. in philosophy from Duke University.

John Lynch

Managing Director for Principal Investments, J.P. Morgan Asset Management - Infrastructure Investments Group, UK



John Lynch joined the Infrastructure Investments Group after a 20-year global career in investment banking. His responsibilities encompass asset management, origination and fund raising. He is a member of the Operating Committee and the Risk Committee. His board roles at the Fund's portfolio companies include two of the fund's most significant investments – ENW Ltd, where IIG owns 50% of the regulated electricity distribution network in Manchester/Northwest England, and Nortegas, where IIG owns ~60% of the incumbent natural gas distribution company in the Basque Region/Northern Spain. Whilst bolstering the fund's strong legacy positions in the UK and

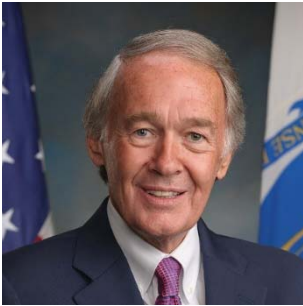
NL and Spain, his origination activities encompass core and core plus assets, management teams and board members across Europe.

From 2010, John was Head of EMEA Power at Bank of America Merrill Lynch, where he led the bank's advisory and lending efforts in Europe for utilities, conventional power, renewable generation and energy/utility related infrastructure. He joined BAML in 2000 and held various roles based in NY and London. Prior to that he was based in NY with JPMorgan IBD in the Energy Group. He started his career with Arthur D. Little in Boston.

John lives in London with his wife and three children. He is a dual citizen – of USA and Ireland. He holds a BA from Dartmouth College and an MBA from the University of Chicago Booth School of Business.

Sen. Ed Markey (D., Massachusetts)

United States Senate, USA (Invited)



Sen. Edward J. Markey is the junior United States Senator from Massachusetts, serving since 2013. A member of the Democratic Party, he was the U.S. Representative for Massachusetts's 7th congressional district from 1976 to 2013.

During his four decades in Congress, Ed has been a consumer champion and national leader on energy, environmental protection and telecommunications policy, with a prolific legislative record on major issues across the policy spectrum – including climate change, clean energy, safeguarding privacy, nuclear non-proliferation, investor protection, and preserving an open Internet that spurs competition and consumer choice. In the House he was the Ranking Member of the Committee on Natural Resources and a member of the Committee on Energy and Commerce, where he served for 20 years as Chair or Ranking Member of the Subcommittee on Telecommunications and the Internet.

Ed graduated from Boston College with a Bachelor of Arts, and from Boston College Law School with a Juris Doctor. After graduating, he worked as a lawyer in private practice. He served in the United States Army Reserve from 1968 to 1973, attaining the rank of Specialist Fourth Class.

Miriam Maes

Chair, Energy Transition Forum; Chairman, Supervisory Board, Port of Rotterdam, UK



Miriam Maes has worked 35 years for multinationals, including more than 20 years managing national and international P&L's. After managing international food, foodservices and beverages businesses for Unilever, ICI and the Marmon Group, in 2002 she entered the energy sector, first with Texas Utilities as a member of their European Executive and subsequently with Electricité de France (EDF) in the UK, as COO of their non-regulated distribution networks' business.

In 2007, Miriam became CEO of Foresee, an energy and climate change strategy consultancy. Between May 2010 and April 2012, she was Advisor to the UK Department for Energy and Climate Change. In 2012, Miriam became a Senior Fellow on the Climate and Energy Program of the German Marshall Fund of the United States (GMF), a Washington-based transatlantic think tank, and became Chairman of GMF's Energy Transition Forum. In 2015, Miriam took ownership of the Energy Transition Forum 2.0 and partnered with the United Nations Foundation.

Until May 2017, Miriam served for six years, first as Member and then as Chairman of the Board, of the Euronext-listed company ELIA Group, comprising Elia, the Belgian national grid operator, and 50Hertz, the German Transmission System Operator. She is currently serving as Chairman of the Supervisory Board of the Port of Rotterdam and as a Non-Executive Director on the Board of URENCO, a joint venture between the UK, German and Dutch governments for the manufacture of enriched uranium for nuclear power utilities worldwide. She is also serving as a Non-Executive Director on the Boards of three Euronext-listed companies in France: Eramet (mining), Vilmorin & Cie (agricultural seeds), and Assystem (Energy Engineering).

Joe McClelland

Director, Office of Energy Infrastructure Security, FERC, USA



Joseph H. McClelland was appointed the first Director of the Office of Energy Infrastructure Security (OEIS) by Chairman Jon Wellinghoff in September 2012. OEIS was created to provide leadership, expertise and assistance to identify, communicate and seek comprehensive solutions to potential risks to FERC-jurisdictional facilities from cyber attacks and such physical threats as electromagnetic pulses.

Prior to directing OEIS, Joe served as the first Director of the Office of Electric Reliability, which was created in 2007. He joined the Commission in 2004 as Director of the Division of Reliability within the Office of Energy Markets and Reliability.

Joe came to the Commission with more than 20 years of experience in the electric utility industry. He began his career with Allegheny Energy Inc., holding a variety of positions in engineering, marketing, regulation and rates, and project development. Immediately prior to joining the Commission, he was the General Manager of the Custer Public Power District in Broken Bow, Nebraska. He holds a Bachelor of Science degree in Electrical Engineering from Pennsylvania State University.

Rajiv Mishra

Managing Director India, China Light and Power, India



Rajiv Mishra is responsible for running CLP's business in India. He joined the CLP Group in 2002 and has over 20 years of experience in the power industry, both in India and internationally, mostly involved in project financing, investment appraisal, finance and accounting and general management. Before assuming the role of Managing Director of CLP India, Rajiv held a variety of senior positions in the Power Industry viz. Deputy Managing Director/Chief Financial Officer of BLC Power in Thailand, Finance Director of PowerGen India and Finance Director of LG Energy in Seoul, South Korea.

Rajiv has successfully transformed CLP India from a single-asset and project management company to a fully-grown organization with presence across conventional and renewables sources of energy. He has also served as the Chairman of Association of Power Producers, a grouping of nearly 90% of India's private power generators and is the Co-Chairman of the Confederation of Indian Industry, one of India's largest industry bodies representing both the public and private sectors.

Rajiv is also a member of a select group of private-sector entrepreneurs and CEOs, formed by India's NITI Aayog (the government think tank) and the Prime Minister's Office, to advise the Government of India on the policy changes required to create a world-class infrastructure in India by 2022.

He holds a Bachelors degree in Chemical Engineering (first class distinction) from BIT, Sindri and an MBA degree from the Indian Institute of Management, Lucknow, and is an Advanced Management Program Graduate from the Harvard Business School, Boston.

Phil Moeller

Executive Vice President, Business Operations Group and Regulatory Affairs, Edison Electric Institute; former Commissioner, Federal Energy Regulatory Commission, USA



Philip D. Moeller is Executive Vice President, Business Operations Group and Regulatory Affairs at the Edison Electric Institute (EEI). EEI is the association that represents all US investor-owned electric companies.

Phil has significant responsibility over a broad range of issues that affect the future structure of the electric power industry and new rules in evolving competitive markets, including energy supply and finance, environment, energy delivery, energy services, federal and state regulatory issues, and international affairs.

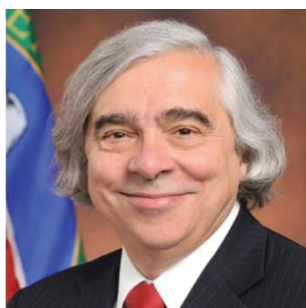
Prior to joining EEI, Phil served as a Commissioner on the Federal Energy Regulatory Commission (FERC) from 2006 through 2015, appointed by both President George W. Bush and President Barack Obama. At FERC, he championed policies promoting improved wholesale electricity markets, increasing investment in electric transmission and natural gas pipeline infrastructure, and enhancing the coordination of the electric power and natural gas industries.

Earlier in his career, Phil headed the Washington, D.C., office of Alliant Energy Corporation. He also served as a Senior Legislative Assistant for Energy Policy to U.S. Senator Slade Gorton (R-WA), and as the Staff Coordinator of the Washington State Senate Energy and Telecommunications Committee in Olympia, Washington.

He was born in Chicago and raised on a ranch near Spokane, Washington. He received a BA in Political Science from Stanford University.

Ernie Moniz

Former US Secretary of Energy; Professor of Physics, MIT; President & CEO, Energy Futures Initiative



Ernest J. Moniz is a nuclear physicist who served under President Obama as Secretary of Energy from 2013 to 2017. His accomplishments include leading an international initiative that placed energy science and technology innovation at the center of the global response to climate change and negotiating the historic Iran nuclear agreement alongside Secretary of State John Kerry.

At MIT, Ernie was the Founding Director of the MIT Energy Initiative (MITEI) and Director of the Laboratory for Energy and the Environment.

He received a Bachelor of Science degree summa cum laude in physics from Boston College and a doctorate in theoretical physics from Stanford University.

David Morenoff

Deputy General Counsel, FERC, USA



David L. Morenoff is Deputy General Counsel at the Federal Energy Regulatory Commission (FERC), having served in several other senior positions at FERC in the Office of the General Counsel and in the office of then-Chairman Jon Wellinohoff. Before coming to FERC in 2006, David worked on electric industry matters in the Washington, D.C., office of Troutman Sanders, LLP. He also served as a legislative assistant on energy and other issues to U.S. Senator Jack Reed of Rhode Island.

He graduated cum laude from Harvard Law School in 2001, having graduated magna cum laude, with honors in history, from Brown University in 1995.

Pete Ogden

Vice President, Energy, Climate, and the Environment, United Nations Foundation, USA



Pete Ogden is Vice President for Energy, Climate, and the Environment at the United Nations Foundation. Prior to joining the Foundation, he was Senior Fellow for International Energy and Climate Policy at the Center for American Progress, Senior Advisor and Fellow at the Energy Policy Institute at the University of Chicago, and Senior Advisor at the Rhodium Group.

During the Obama Administration, he served in the White House as Senior Director for Energy and Climate Change on the Domestic Policy Council and Director for International Climate Change and Environmental Policy on the National Security Council, as well as at the State Department as Chief of Staff to the Special Envoy for Climate Change. Before his government roles, he was the Chief of Staff at the Center for American Progress. His writing on energy and climate issues have appeared in Foreign Affairs, the Financial Times, the Washington Post, and a variety of other outlets.

Richard O'Neill

Chief Economic Advisor, FERC, USA



Richard O'Neill has served as the Chief Economic Advisor for the Federal Energy Regulatory Commission since 1985. Previously, he was Director of the Office of Economic Policy and Office of Pipeline and Producer Regulation. From 1978 to 1986, he directed oil and gas analysis and forecasting at the Energy Information Administration. From 1973 to 1978, he was on the Louisiana State University computer science faculty. From 1969 to 1973, he was on the University of Maryland business school faculty.

His work with governments and companies has included mathematical software, energy modeling, forecasting, open access, restructuring, competition, performance-based regulation, market power mitigation and market design. His work has appeared in journals and books in Applied Mathematics, Optimization, Operations Research, Computer Science, Energy, Electrical Engineering, Economics, and Law. He is a Fellow of INFORMS and an Associate Researcher in the University of Cambridge Energy Policy Research Group. In 2016, he received the International Association of Energy Economics Outstanding Contributions to Energy Economics Award.

He has a B.S. in chemical engineering, an MBA and a Doctorate in operations research from the University of Maryland.

Andy Ott

President and CEO, PJM Interconnection, USA



As president and chief executive officer of PJM, Andrew L. Ott oversees the largest power grid in North America and the largest electricity market in the world. A 20-year veteran with PJM, he became the CEO in October of 2015. He also serves as a PJM Board member.

Andy was responsible for design and implementation of the PJM wholesale electricity markets. He has extensive experience in power system engineering, transmission planning, applied mathematics, electricity market design and implementation. He is internationally recognized as an expert in electricity market design.

Andy is Chair of CIGRE (International Council on Large Electric Systems) Study Committee C5, on Electricity Markets and Regulation. He is an IEEE Fellow. He had served on the board of the Association of Power Exchanges for eight years. He also serves on the Board of GO 15, which is a voluntary initiative of the world's 18 largest power grid operators representing more than 70 percent of the world's electricity demand and providing electricity to 3.4 billion consumers on six continents.

Prior to joining PJM, Andy was employed by GPU, Inc. for 13 years in transmission planning and operations. He received a Bachelor of Science in electrical engineering from The Pennsylvania State University and a Master of Science in applied statistics from Villanova University.

Derek Parkin

Chief Operating Officer, China Light and Power, Hong Kong



Derek Parkin is Chief Operating Officer of CLP Holdings Limited. He is responsible for the Group's operations, engineering, construction and fuel procurement. He also leads CLP's occupational health, safety and environment functions.

Derek has over 30 years of engineering and business management experience across Europe, Russia, Asia and South America. Prior to joining CLP, he was the Chief Operating Officer/Chief Executive Officer of UK Coal and served on the executive board of power and gas giant E.ON UK

for more than five years before being appointed as the Managing Director of New Build and Technology of E.ON.

Earlier in his career, Derek worked in the construction industry with a FTSE 100 company and worked on a number of major infrastructure projects worldwide, including the construction of the Hong Kong International Airport, the Channel Tunnel and Heathrow Terminal 5. A chartered engineer, he holds an Executive MBA degree, a Master of Philosophy degree in Engineering and a BSc (Hons) in Mining Engineering.

Larry Parkinson

Director, Office of Enforcement, FERC, USA



Larry R. Parkinson is the Director of the Office of Enforcement. From March 2010 to April 2015, he served as Director of the Division of Investigations in the Office of Enforcement. Before joining FERC, he served as Deputy Assistant Secretary at the U.S. Department of the Interior, General Counsel of the Federal Bureau of Investigation, General Counsel of the U.S. Small Business Administration, Assistant United States Attorney for the District of Columbia, litigation associate at Ropes & Gray, and law clerk to the Honorable William G. Young of the U.S. District Court for Massachusetts. He has twice received a Presidential Rank Award for

Meritorious Service.

Larry is a graduate of Northern State University and Harvard Law School, where he served as an editor of the Harvard Law Review. Before law school, he worked for four years on Capitol Hill as a staff member to two congressmen and as a subcommittee minority staff director.

Theresa Payton

President and CEO, Fortalice Solutions; CIO, President George W. Bush Administration, USA



The founder, president and CEO of the cybersecurity consulting company Fortalice Solutions, LLC and co-Founder of Dark3, a cybersecurity product company, Theresa Payton has been named by IFSEC Global as 4th among the top 50 of the world's cybersecurity professionals and by Security Magazine as one of the top 25 Most Influential People in Security.

The first female to serve as White House Chief Information Officer, she oversaw IT operations for the President and his staff from 2006 to 2008 during a period of unprecedented technological change and escalating threats. Previously, she held executive roles in banking technology at Bank of America and Wells Fargo.

Fortalice Solutions was recently named one of the Top 5 Innovative Cybersecurity companies in the D.C./MD/NoVa region, and Theresa was awarded the Enterprising Women of the Year Award for the 2nd year in a row. She is often sought out by national and international media news outlets to explain complex security issues in business and consumer terms to get behind the hype and say, in layman's terms, how to protect your privacy and security. She has been a repeat guest on the Today Show, Good Morning America, Fox Business Shows, Fox News Shows, CBS Morning & Evening News, BBC TV News and Radio, CBSN, CNN, NBC News, MSNBC, and NPR.

Recognized as a 2015 William J. Clinton distinguished lecturer by the Clinton School of Public Service, Theresa passionately protects her clients, from the board room to the server room, and helps them understand the business risks to their organization's security from rapidly evolving cyberattacks.

John Podesta

Former White House Chief of Staff and Counselor, Presidents Obama and Clinton; Founder, Center for American Progress



John D. Podesta served as White House Chief of Staff to President Bill Clinton and as Counselor to President Barack Obama. He is the former president, and now Chair and Counselor, of the Center for American Progress, a think tank in Washington, D.C., as well as a Visiting Professor of Law at the Georgetown University Law Center.

John became an honorary patron of the University Philosophical Society in March 2006. He is an emeritus member of the Knox College Board of Trustees. He has served on the board of directors of Bedford, Massachusetts-based energy company Joule Unlimited since January 2011.

He graduated from Knox College and received his J.D. from Georgetown University Law Center.

Rich Powell

Executive Director, ClearPath Energy Action, USA



Rich Powell is the Executive Director at ClearPath Foundation, where he leads the day-to-day operations of ClearPath programs, including policy and strategy. He focuses on educating policymakers on investing wisely in energy innovation, and maintaining and promoting baseload clean energy resources. Rich also leads ClearPath's external advocacy and research partnerships with non-profits, academia, and the private sector.

Previously, Rich was with McKinsey & Company in the Sustainability and Resource Productivity Practice. He focused on clean energy strategy, residential energy efficiency, low carbon growth, and clean tech market entry. He served clients across the private, public, and social sectors.

Stephen Prince

CEO, Centrica Business Solutions North America, USA



Stephen Prince is the Head of Centrica Business Solutions North America. He is responsible for commercial operations and driving growth across three key strategy areas – energy insight; energy optimization; and energy solutions, including combined heat and power (CHP), solar, battery storage and standby generators. In addition, Stephen works closely with Centrica's Direct Energy Business team to put customers in control of their energy – from energy supply to distributed energy solutions.

Prior to joining Centrica, Stephen served in a variety of leadership roles, most recently as President and CEO of Younicos, a global leader in battery storage and microgrid solutions sold to Aggreko in July 2017. He previously served in executive leadership positions in industry, software, consulting, and outsourcing companies within the utility, financial service, and public transportation sectors, holding titles of Chief Executive Officer, Managing Director, Chief Accounting Officer, Global Practice Leader, and Senior Vice President of Strategy, Business Development, Sales, Channel Management, Product Management, and Innovation.

Stephen earned an M.S. degree in Tax from the Golden Gate University School of Taxation, a Contracts Management Certificate from the University of California, Irvine, and a B.A. degree in Business Administration and Accounting from California State University, Fullerton.

Gerard Reid

Co-Founder & Partner, Alexa Capital, UK



Gerard Reid has over two decades' experience in research and fund management. He is also a lecturer, professor and author on energy and renewable energy.

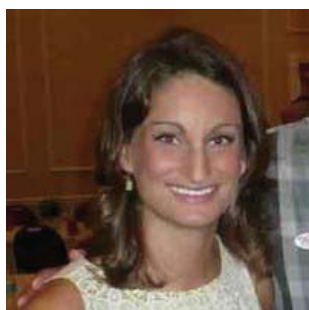
Prior to founding Alexa Capital, he was Managing Director and Head of European Cleantech Research at Jefferies & Co. While at Jefferies, as a senior member of the Global Cleantech Research team, he also helped found and build the #1 global industry and investor conference platform in the new energy sector, hosted in both New York and London.

Gerard joined Jefferies from Ardour Capital, the alternative energy-focused investment bank and fund manager, where he was a Managing Director and Head of Europe. Prior to this he was Head of Research at First Berlin, where he expanded the cleantech equity research operation to cover 50 companies. He is also a founding partner of Swancreek Energy, a leading US solar PV developer.

He is an Adjunct Professor at Imperial College, London and lecturer at the University of Applied Science and the Technical University in Berlin. He has published a number of books and papers, including co-authoring the report for the German government: "A Global Renewables Investment Plan" and authored *The Great Energy Game* (published in September 2010 in German as *AsiensEnergiehunger: Rohstoffe am Limit*). He holds a Higher Diploma in Education and MA in Business & Economics from Trinity College.

Annelise Rickert

Senior Counsel, House Energy & Commerce Committee, Majority Staff



Annelise Rickert has served as Senior Counsel at the Energy and Commerce Committee of the U.S. House of Representatives since 2015. As Senior Counsel, she is responsible for an energy policy portfolio which includes issues relating to electricity, technology and innovation, and cyber security. She works on issues including the Clean Air Act, emissions, electricity and grid reliability, and oil and gas.

She received her BA and JD from Loyola University, New Orleans.

Gregg Rotenberg

CEO, Smart Wires, USA



As CEO of Smart Wires, Gregg Rotenberg is focused on understanding the current and future needs of global transmission organizations and leading the development and commercialization of the company's solutions. He comes from a strategy consulting background and is passionate about understanding the strategic objectives of the executives who operate the world's largest grids. This insight allows Smart Wires to continually develop "game changing" solutions for transmission industry leaders. Gregg's other key focus is on assembling a uniquely talented team that is passionate about making Smart Wires customers successful.

Prior to Smart Wires, Gregg created and was the general manager of the Renewable Power Group at Chevron, which produced earnings that exceeded Chevron's targets by an average of 300%. He also managed Chevron's Strategic Alliances Group, which reviewed more than 1,000 companies in a five-year period to identify truly revolutionary energy technologies. In this period, only three technologies were designated as truly revolutionary, and one of those technologies was Smart Wires.

At Chevron, Gregg led the engineering, procurement, construction (EPC) and investment of 200 MW of utility-scale solar and geothermal projects. Prior to Chevron, he co-led the development of a new energy consulting practice at one of the world's largest energy firms. Gregg was also a principal and founder at Keystone Strategy, a leading strategy consulting firm that was launched by three Harvard Business School professors.

Gregg holds a bachelor's degree with a concentration in finance and accounting from the Wharton School of the University of Pennsylvania, magna cum laude, and an MBA from Northwestern University's Kellogg School of Management, where he graduated first in his 700+ person class.

Don Santa

President, Interstate Natural Gas Association of America; former Commissioner, FERC, USA



Don Santa is the President and CEO of the Interstate Natural Gas Association of America (INGAA), the North American association representing the interstate and interprovincial natural gas pipeline industry. He has an extensive background in government and in the energy industry.

He served as majority counsel to the U.S. Senate Committee on Energy and Natural Resources from 1989 to 1993, where he worked on enactment of the Natural Gas Wellhead Decontrol Act of 1989 and the Energy Policy Act of 1992.

Don was nominated in 1993 to be a member of the Federal Energy Regulatory Commission, where he served until 1997. During his tenure as a commissioner, he worked on major FERC initiatives including Order No. 888 (open access rule for electric transmission) and implementation of Order No. 636 (the rule restructuring natural gas pipeline services).

Upon leaving the government, Don joined LG&E Energy Corp in Louisville, KY, where he served as Deputy General Counsel and Senior Vice President for Strategic Planning from 1997-2001. Before joining INGAA, he was a partner in the Washington, DC office of Troutman Sanders LLP, where he was a member of the federal regulatory practice group. He became INGAA's Executive Vice President in January 2003 and CEO in August 2003. He is a graduate of the Columbia University School of Law and the Duke University Trinity College of Arts and Sciences.

Eric Schmitt

VP of Operations, California Independent System Operator, USA



Eric Schmitt is Vice President, Operations at the California ISO, where he is responsible for California's bulk electric system operations, real-time engineering, training, and market settlements. Mr. Schmitt is a 35-year power industry veteran with a unique blend of experience in operations, engineering, technology, business and environmental program management.

Prior to joining California ISO, Eric served as Senior Vice President at Science Applications International Corporation (SAIC), based in McLean, Virginia.

Over his career, he has held a variety of technical and management positions within the industry, including significant responsibilities in electricity production, transmission, operations, technical support, and information technology. Also, he has consulted at various electric utilities worldwide, working with clients assisting them with operations, engineering, business process and technology challenges.

Eric's education includes a Master of Business Administration from University of Texas and a Master of Environmental Science from Florida Institute of Technology. He earned a Bachelor of Science from University of Notre Dame.

Armin Schnettler

Senior VP, Research in Energy and Electronics, Siemens, Germany



Prof. Dr.-Ing. Armin Schnettler joined Siemens in 2013 as Head of New Technology Fields, Siemens Corporate Technology, and is since 2016 Head of Research in Energy and Electronics, Siemens Corporate Technology.

He studied electrical engineering with a PhD thesis on the application of multivariate statistics and artificial neural networks for partial discharge pattern recognition at the University of Technology in Dortmund, Germany. He joined ABB in 1992 and held several positions within ABB AG, Mannheim, as well as ABB Corporate Research Ltd, Heidelberg. In 1998,

he became a Member of the Management Team of ABB's business area "High Voltage Products and Substations", in Zurich.

In 2001 Armin joined RWTH Aachen University with a full professorship and Director of the Institute for High Voltage Technology. From 2003 to 2013 he was appointed Managing Director of Forschungsgemeinschaft für elektrische Anlagen und Stromwirtschaft e.V. (FGH e.V.), the Research Association of Power Systems and Power Economics (non-profit organization).

Armin is scientific advisor and member of many national and international organizations and committees and Editor-in-Chief of “Archiv für Elektrotechnik – Electrical Engineering”.

Harald Schrimpf

Chairman, PSI Software, Germany



Dr. Ing. Harald Schrimpf became a member of the executive board in July 2002 and has been CEO of the PSI Software AG since July 2013. Since 1995, the graduate electrical engineer has held different management positions at DaimlerChrysler, EADS, and the Volkswagen subsidiary gedas, with responsibility for major IT projects.

His main target is to focus PSI on software product business and to further expand international business, profitability and growth. PSI is a global leader in software solutions for utilities and industry, with extensive experience in transmission Energy Management Systems (EMS) and

renewable energy.

Fintan Slye

CEO, UK System Operator, National Grid, UK; former CEO, EirGrid, Ireland



Fintan Slye was appointed Director, UK Electricity and Gas System Operator at National Grid in the UK at the end of 2017. Prior to his new role, he was Chief Executive of EirGrid since 2012.

In 2017, Fintan was also elected as vice chairman of the Board of Entso-e (the European Organisation for Transmission Grid Operators) and as a Fellow of the Institute of Engineers Ireland.

Before becoming CEO of EirGrid, he had previously held the position of Director of Operations, in which he had responsibility for the operation of the power system in Ireland and Northern Ireland, as well as for managing EirGrid and SONI's programme of work to facilitate the integration of world-leading levels of renewables on the power system.

Before his appointment to that position, Fintan worked for McKinsey & Co in their Dublin office, supporting companies across Ireland, UK and Europe. Prior to that, he held several project and management roles in ESB National Grid and ESB International.

Fintan completed a master's degree in business administration from UCD in 2001 and a master's in engineering science in 1993.

Jerry Taylor

President, The Niskanen Center, USA



Jerry Taylor is the president of the Niskanen Center. Prior to founding the Center in 2014, Mr. Taylor spent 23 years at the Cato Institute, where he served as director of natural resource studies, assistant editor of Regulation magazine, senior fellow, and then vice president. Before that, Mr. Taylor was the staff director for the energy and environment task force at the American Legislative Exchange Council (ALEC).

Over the past two decades, Mr. Taylor has been one of the prominent and influential libertarian voices in energy policy in Washington. He is the author of numerous policy studies, has testified often before Congress, and his commentary has appeared in The Washington Post, New York Times, Wall Street Journal, and other prominent print and electronic outlets.

Gerassimos Thomas

Deputy Director General for Energy, European Commission, Belgium



Gerassimos Thomas is Deputy Director General in the Directorate-General for Energy and Chairman of the Steering Board of the European Fund for Strategic Investments (EFSI). Prior to his current assignment he had professional assignments as: Director Finance at DG ECFIN (2009-2014); member of the EIB and EIF Board of Directors (2009-2017); Head of cabinet of Joaquin Almunia, Commissioner for Economic and Monetary Affairs (2005-2009); Deputy Spokesman for Commission President Romano Prodi; Spokesman for economic and monetary affairs for Commissioner Pedro Solbes (2000-2004). Prior to 2004 held various

positions in the European Commission, the European Investment Fund and in investment banking in London.

He has studied economics, business administration and international relations in Athens, London and Brussels.

Barbara Tyran

Executive Director, Government & External Relations, Electric Power Research Institute, USA



Barbara Tyran is Executive Director, Government & External Relations, in EPRI's Washington DC office. She serves as the principal liaison between EPRI executive management, and Congress, the Administration, the national trade associations, the national leadership of the state public utility commissions, state legislators/regulators, and the Washington energy community.

Barbara joined EPRI in 1998 after serving for several years as Manager of Federal Government Affairs for two electric utilities, Kansas City Power & Light and Empire District Electric Company. Previously, she was the Washington Representative for DTE Energy, having worked as a management consultant, initially with Booz Allen & Hamilton, and subsequently, with Pace Global, where she was engaged with energy-related clients in both the private and public sectors.

Barbara currently chairs the Industry Advisory Committee for the 2019 and 2020 IEEE Innovative Smart Grid Technologies Conferences. She is Chairman, Association of State Energy Research and Technology Transfer Institutions, and Vice President of the Women's Council on Energy & the Environment. She holds a BA degree with Honors from Stanford University and an MBA from Yale University.

Rep. Fred Upton (R., Michigan)

Member of the Congressional Climate Solutions Caucus, US House of Representatives, USA (Invited)

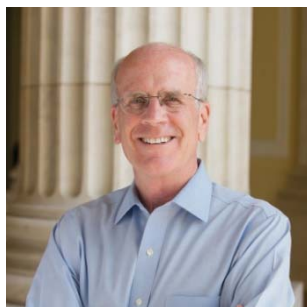


Rep. Fred Upton has represented Michigan's 6th district since his election to Congress in 1987. Throughout his tenure, he has served as a leader in legislation of the environment and energy industry. In 2007, Upton co-sponsored the Energy Independence and Security Act of 2007 which among other things mandated phased-in energy efficiency standards for most light bulbs. He also served as Chairman of the House Committee on Energy and Commerce from 2011-2017. Currently, he serves as a member of that committee as well as the Joint Select Committee on Deficit Reduction.

He graduated with a B.A. in Journalism from the University of Michigan.

Rep. Peter Welch (D., Vermont)

**Member of the Congressional Climate Solutions Caucus, US House of Representatives, USA
(Invited)**



Rep. Peter Welch has represented the sole congressional district in Vermont since his election to Congress in 2006. In 2011, Peter was appointed to serve as a Chief Deputy Whip of the House Democratic Caucus. He serves on the Committee on Agriculture and the Committee on Oversight and Government Reform. As a member of the House, Peter has championed legislation to make homes and buildings more energy efficient, provide tax incentives for the production of renewable energy and energy conservation, and authorize Federal agencies and legislative branch offices to purchase greenhouse gas offsets and renewable energy credits.

He graduated magna cum laude from the College of the Holy Cross and graduated from the law school at the University of California, Berkeley.

Gordon van Welie

President and CEO, New England Independent System Operator, USA



Gordon van Welie oversees New England's 32,000-megawatt bulk power system, the multi-billion dollar wholesale electricity marketplace, and a robust system planning process. He has been president and CEO of ISO New England since 2001, leading the strategic initiative to keep New England's power system reliable while it undergoes a dramatic transformation from oil, coal and nuclear generation to natural gas, renewable and distributed resources.

Before ISO New England, Gordon was Vice President and General Manager of Power System Control for Siemens. Earlier in his career, he worked in various roles with the South African utility, Eskom. He is a member of the National Academy of Engineering, the North American Electric Reliability Corporation Member Representatives Committee, the ISO/RTO Council, and the IEEE Power & Engineering Society.

Gordon holds a Bachelor of Science degree in Electrical Engineering and an MBA from University of Witwatersrand in South Africa.

Sandra Waldstein

Director, Division of State, International and Public Affairs, FERC, USA



Sandra Waldstein is the Director of State, International and Public Affairs at the Federal Energy Regulatory Commission (FERC). She came to FERC in 2008 after 14 years at the Vermont Public Service Board where she was a Senior Policy Advisor. At the Board she had primary responsibility for issues related to the regional electricity market in New England including revisions to market rules, market monitoring, system planning, and integration of demand side resources. At FERC she directs the liaison and outreach activities with state energy policy makers, international energy officials, U.S. industry and members of the public.

Sandra has worked on international energy issues in Europe, India, South Africa and China. She has a Master's degree in Public Administration and completed post-graduate work in economics.

Michael Walsh

Managing Director Europe, Smart Wires, UK



Based in Dublin, Michael Walsh is responsible for leading the Smart Wires business in the Europe Region.

Prior to joining Smart Wires, he was Director of Future Grids at Ireland's Transmission System Operator, EirGrid, where he was responsible for planning the transmission system on the island of Ireland and bringing new technologies into its grid development strategy.

He was a member of ENTSO-E's System Development Committee, which oversees the planning of the European transmission system.

Before that he was Chief Executive of the Irish Wind Energy Association and a board member of the European Wind Energy Association.

Other previous roles include Manager of Market Readiness at ESB National Grid and a lecturer in Electronic Engineering at University College Dublin, Ireland.

Michael is a Fellow of Engineers Ireland and a member of the board of the Energy Institute at UCD. He holds a BE, MBA and PhD and has authored many peer-reviewed papers and advised a wide variety of international bodies.

Jon Wellinghoff

CEO, GridPolicy Consulting; former Chairman, FERC, USA



Jon Wellinghoff is known for his international expertise and thought leadership in energy policy, electric markets and the interface of disruptive energy systems with traditional utility structures. His firm GridPolicy is dedicated to furthering the deployment of and investment in clean sustainable distributed energy resources (DERs).

Jon works to remove regulatory, policy, and institutional barriers to the widespread adoption of cost-effective DER technologies and systems, assisting companies, governments, and consumers who market and/or operate such resources.

In 2006, he received his first of two Presidential appointments to serve as a Commissioner on the Federal Energy Regulatory Commission (FERC), and was FERC's longest-serving Chairman (2009-2013). During his FERC tenure, he led efforts to make the U.S. power system cleaner and more efficient by promoting and integrating renewable energy, demand response, energy efficiency and storage.

Jon was most recently Chief Policy Officer at SolarCity, the largest provider of distributed solar energy systems in the U.S., where he oversaw all regulatory and legislative policy for the company. Previously, he served as partner and co-chair of the energy law practice at the law firm Stoel Rives, where he consulted on energy policy with leaders in the U.S., China, Australia and Europe. Jon earlier served in state government as General Counsel at the Nevada Public Utilities Commission and was Nevada's first Consumer Advocate, representing the interests of utility consumers.

Rudy Wynter

President & COO - Transmission, Generation and Energy Procurement National Grid US, USA



Rudolph Wynter oversees businesses with an asset base of \$4.5 billion, including one of the largest electric transmission networks in the northeast. He is leading the transformation of that network into a highly intelligent, resilient system that will meet customers' long-term needs and enable the clean energy future.

He also oversees the company's regulated energy storage assets and opportunities, including the development of New England's first large-scale battery energy storage system on the island of Nantucket. His team is collaborating with the Department of Energy's Pacific Northwest National Laboratory on research on transmission grid modernization and energy storage technologies.

Rudy also is responsible for the company's generation fleet, which provides 4,000 megawatts of electricity to more than a million Long Island Power Authority (LIPA) customers. He oversees National Grid's energy procurement activities, including a portfolio of natural gas and power supply agreements that total \$5 billion annually.

Previously he was senior vice president of US Shared Services, and during his more than 25-year tenure at National Grid and its legacy companies has held positions of responsibility in Customer

Operations, Strategic Planning, Engineering, and Operations. He is a member of The American Society of Mechanical Engineers, the American Gas Association, and the Edison Electric Institute.

Rudy serves on the boards of Ascendant Group Limited, a Bermuda-based, publicly traded provider of energy and energy-related services; and the Brooklyn Historical Society. He earned his Bachelors in Mechanical Engineering from Pratt Institute, an MBA from Fordham University, and has completed an executive development program at Harvard University.

Felix Zhang

Group Executive Director and Venture Partner, Envision Energy (renewable energy), China/USA



Felix Zhang runs the international businesses of Envision Group, having co-developed the company from an idea in London to a leader in the renewable energy and technology space. He has lived, worked and is at home in North America, Europe and Asia. His experiences prior to forming Envision Group include investment banking at Morgan Stanley, capital markets at CIBC and investing as a partner at a hedge fund.

He is passionate about technology start-ups, having invested in over 20 as an angel investor. Felix has an undergraduate degree in applied mathematics and sciences from the University of Wisconsin, and a master's degree from University of St. Thomas, and attended the AMP programs at Harvard Business School.



Energy Transition Forum 3.0 Site Visit and Workshop 28-30 November 2018

Washington, DC, USA

“Emerging Threats and Opportunities: Cybersecurity, Political Change, and the Future of Natural Gas”

The continuing transition in the energy industry faces new headwinds, not just from technological change but from rapidly evolving cyber threats, sudden political shifts, and uncertainty about the future role and sources of natural gas.

At the next session of the Energy Transition Forum in Washington, D.C., we will discuss these issues with experts from the US Federal Energy Regulatory Commission, political insiders and global industry experts.

Themes:

- *Implications of the U.S. mid-term elections for energy and climate policy*
- *Key driver in the electricity and gas sector: regulation or market forces?*
- *The energy transition on the ground: latest developments and implications*
- *Cybersecurity challenges and responses by power companies and authorities*
- *The evolving role of natural gas in the energy transition*

***Organized by the Energy Transition Forum
in partnership with the United Nations Foundation***



We thank the Sponsors of the Energy Transition Forum:



Background Information – The Energy Transition Forum 3.0

The Energy Transition Forum (ETF) seeks to generate frank discussion, innovative thinking, and concrete solutions and actions about the ways in which participants from the United States, Europe and Asia can work together to achieve a timely and responsible transition to a secure, affordable and low-carbon global energy system, with emphasis on the rapidly evolving electric power industry.

The ETF does this through a series of facilitated off-the-record dialogues between influential energy leaders (C-level) from the private and public sectors, academic thought leaders, and subject-matter experts that look at the impact of the latest energy challenges, new market entrants and energy technologies to define potential solutions in terms of innovative market and financial mechanisms, new business models and reforms to policy and regulation.

Initiated in 2012 by the transatlantic think tank The German Marshall Fund of the United States, the Energy Transition Forum has been successfully working ever since to address the increasingly complex challenges of the energy value chain, based on the implementation of the two ETF pillars: “**total systems thinking**” and the “**dialogue method**”.

This approach has already catalyzed surprising business and political insights, cutting-edge thinking, and practical innovative solutions. Perhaps even more importantly, the ETF’s structure has led to strong personal commitments, effective relationships and a coalition of people who are strongly motivated to understand, navigate and accelerate the on-going energy transition within their own professional environment, producing a “pebble in the pond” effect.

**“Never doubt that a small group of thoughtful, committed citizens
can change the world. Indeed, it’s the only thing that ever has.”**

– Margaret Mead, *Cultural Anthropologist*

When the first incubation period of the ETF at the German Marshall Fund came to a natural end, participants urged that the program continue. Thus was launched “ETF 2.0” in October 2015. Two years later, a similar reassessment led to a new program of activity (“ETF 3.0”) with workshops in Berlin and Washington, D.C., in 2018. Future workshops are envisioned for Paris and potentially Asia in 2019.

The ETF is chaired by Miriam Maes in London, with support in Europe from Christophe Brognaux and Gerard Reid and in the US from Reid Detchon, John Jimison, Andy Ott and Jon Wellinghoff. The ETF’s sponsors, whose contributions make the ETF possible, include Boston Consulting Group, California ISO, Citigroup, EirGrid, IBM, National Grid, Siemens, Smart Wires, and UK Power Networks.



Washington, DC – 28-30 November 2018

***“Emerging Threats and Opportunities:
Cybersecurity, Political Change, and the Future of Natural Gas”***

A highly interactive discussion and deeper dialogue is at the core of every Energy Transition Forum workshop. Each participant serves as a “speaker” throughout the two days by contributing their perspectives, based on their own experiences and observations, and sharing their questions and uncertainties. The high level and broad range of participants – representing the different industries along the value chain, as well as governments and academia – combined with the intimacy of the group and use of the Chatham House Rule, ensures a lively, candid, and productive exchange of views. Selected participants are asked to prepare comments in advance of the workshop, to “seed” each discussion.

Wednesday, November 28th

9:45am Assemble in the lobby of the Hay-Adams Hotel
800 16th Street, NW
Washington, DC 20006

10:00am Bus transport from Hay-Adams Hotel to Capitol Hill
Drop-off location:
Garfield Circle
1st Street & Maryland Avenue, SW

10:30am Walk to Capitol Visitor Center and security check
Please bring your passport or other formal identity papers!

11:00am **Briefing on Capitol Hill**
Capitol Visitor Center
Meeting Room
East Capitol Street and 1st Street, NE
Washington, DC 20002

“The Outlook for Energy and Climate Legislation in 2019-20”

Panel discussion with senior policy staff from Republican and Democratic offices

Moderator: John Jimison, Executive Director, Americans for a Clean Energy Grid, USA

Presenters: ***Kellie Donnelly**, Senior Counsel, Senate Energy & Natural Resources Committee, Majority Staff*
***Sam Fowler**, Chief Counsel, Senate Energy & Natural Resources Committee, Minority Staff (Invited)*
***Annelise Rickert**, Senior Counsel, House Energy & Commerce Committee, Majority Staff*
***Rick Kessler**, Senior Adviser, House Energy & Commerce Committee, Minority Staff*

Session Objectives

- 1) Understand the implications of the US mid-term elections on energy and environmental policy as perceived by leaders of the US Congress.
- 2) Discuss impacts of policy on practical challenges faced by utilities globally, especially cybersecurity, new market entrants, and the future of natural gas.

12:15pm Luncheon and discussion with Congressional energy leaders
Capitol Visitor Center

“Bringing Climate Change Imperatives Back into US Energy Policy”

Presenters:



Senator Ed Markey (D., Massachusetts) (Invited)



US Representative Carlos Curbelo (R., Florida) (Invited)
Chair of the Congressional Climate Solutions Caucus



US Representative Peter Welch (D., Vermont) (Invited)
Member of the Congressional Climate Solutions Caucus

1:30pm Exit the US Capitol through security and walk to meeting location
Meeting location:
Peace Circle
1st Street & Pennsylvania Avenue, NW

1:45pm **Bus transportation to Federal Energy Regulatory Commission (FERC)**
 888 First Street, NE
 Washington, DC 20426

Session Objectives

- 1) Understand the roles of federal versus state and local utility regulation in the US, particularly in contrast to regulators in Europe and the rest of the world.
- 2) Learn the US federal government's approach towards dealing with cybersecurity and physical threats to the grid, both now and as planned.
- 3) Discuss FERC's role in the US power markets, including the novel market mechanisms developed for energy efficiency and demand response.
- 4) Hear the perspective of the key staff on how the grid is evolving and what FERC's role needs to be in shaping that evolution.

2:00pm Arrival at FERC for passport and security check
Please bring your passport or other formal identity papers!
(Luggage can be left securely in a room near the entrance to the building)

2:15pm **Welcome and Introduction to FERC**
FERC Hearing Room
Speakers: *Sandra Waldstein, Director, Division of State, International and Public Affairs*
David Morenoff, Deputy General Counsel

The Federal Energy Regulatory Commission is an independent US agency. Its five members are nominated by the President and approved by the Senate. FERC has the obligation to ensure that the wholesale power markets and transmission grid operate with reasonable rates, without undue discrimination, and with reliability and resilience. Direct regulation of utilities is the responsibility of the States.

2:30pm ***"The Resilience of the Grid: Cybersecurity, Physical Security and the Energy Transition"***

Speaker: *Joe McClelland, Director, Office of Energy Infrastructure Security*

As generation becomes more decentralized and integrated with transmission and distribution through digital technologies, the risks of cyberattacks are increasing. As shown by the 2013 attack on the PG&E Metcalf substation in the US, physical security cannot be ignored. What is being done at the federal level to protect against these threats?

2:45pm **Discussion with ETF participants**
Moderator: *John Jimison*

3:00pm ***"FERC's Operations Center and Market Oversight Center"***

Presenters: *Larry Parkinson, Director, Office of Enforcement*
Andrew Dodge, Director, Office of Electric Reliability

FERC holds a unique position in the US regulatory landscape, supervising bulk power transmission rates and interstate natural gas sales, and the markets they affect. The

Commission houses electronic Operations and Market Oversight Centers to enable it to perform its oversight effectively and rapidly. How does FERC use these centers to support system reliability and market stability?

3:30pm **Discussion with ETF participants**

3:45pm Tea and coffee break
Portrait Gallery

4:15pm ***“Challenges of the Transition from a US Federal Regulatory Perspective”***

As the transition in the electric sector changes the technologies, the competitive landscape, the utility business models, the roles and options of customers, and the environmental, reliability, and resilience challenges of the sector, how do the heads of FERC’s key offices see the Commission’s evolving regulatory and market-supervising roles? What challenges do they see ahead for the Commission? Are 20th-century laws and regulatory jurisdictions impeding the transition to a 21st-century power grid?

Presenters: *Jignasa Gadani, Acting Head, Office of Energy Policy and Innovation*
Richard O’Neill, Chief Economic Advisor
Anna Cochrane, Head, Office of Energy Market Regulation

5:00pm **Discussion with ETF participants**

Moderator: *John Jimison*

6:00pm **Bus transportation to Hay-Adams Hotel**
800 16th Street, NW
Washington, DC 20006

6:45pm Assemble in the lobby of the Hay-Adams Hotel

7:00pm Walk to the Metropolitan Club (5-minute walk)
The Metropolitan Club, Grill Room
1700 H Street, NW
Washington, DC 20006

Please note: Business attire is required by the Club (coat and tie for men)

7:15pm **Reception sponsored by Siemens**

7:45pm **Dinner sponsored by Siemens, inviting FERC Commissioners and Senior Staff**

Welcome: *Armin Schnettler, Head of Research in Energy and Electronics, Siemens Corporate Technology*



Remarks: “The Key Challenges of the Energy Transition from the Perspective of the Climate Targets and the Realistic Pathways to Achieve Them”

Speaker: *Rachel Kyte, Chief Executive Officer of Sustainable Energy for All, and Special Representative of the United Nations Secretary-General for Sustainable Energy for All*

Rachel Kyte served until December 2015 as World Bank Group Vice President and Special Envoy for Climate Change, leading the Bank Group’s efforts to campaign for an ambitious agreement at the 21st Convention of the Parties of the UNFCCC (COP 21). She was previously World Bank Vice President for Sustainable Development and was the International Finance Corporation Vice President for Business Advisory Services.



Keynote Remarks: “Looking at the Transition in the Energy Sector from the Perspective of the US Congress”

Speaker: *U.S. Representative Fred Upton (R., Michigan) (Invited)*

Rep. Fred Upton has represented Michigan’s 6th district since his election to Congress in 1987. Throughout his tenure, he has served as a leader in legislation of the environment and energy industry. In 2007, Upton co-sponsored the Energy Independence and Security Act of 2007 which among other things mandated phased-in energy efficiency standards for most light bulbs. He also served as Chairman of the House Committee on Energy and Commerce from 2011-2017. Currently, he serves as a member of that committee as well as the Joint Select Committee on Deficit Reduction.

Thursday, November 29th

- 7:45am Assemble in the lobby of the Hay-Adams Hotel
800 16th Street, NW
Washington, DC 20006
- 8:00am Walk to the United Nations Foundation (10-minute walk)
United Nations Foundation
Board Room, 12th Floor
1750 Pennsylvania Avenue, NW
Washington, DC 20006
- 8:15am **Continental breakfast and networking**
- 9:00am **Welcome: Pete Ogden, Vice President for Energy, Climate and the Environment,**
United Nations Foundation
- 9:15am **Introduction to the Energy Transition Forum**
Miriam Maes, Co-Chair, Energy Transition Forum, UK; Chairman, Supervisory Board, Port of Rotterdam, Netherlands

9:45am **“Check-in” and self-introduction of participants**
Reid Detchon, *Senior Advisor for Climate Solutions, United Nations Foundation*

10:45am Tea and coffee break

11:00am **Session 1: Implications of the US mid-term elections**

The 2018 mid-term elections in November 2018 offer the potential of change in the control of the US Congress and the power of the White House. This panel of political experts will discuss what the electoral results mean for the political direction of the United States, including energy and environment policy, and for US participation in the global energy transition and movement toward a decarbonized economy.

Session Objectives

- 1) Learn what messages voters sent to Washington in the mid-term elections and the impacts on the strategy and prospects for re-election of President Trump in 2020.
- 2) Understand the implications of the US election for energy and environmental policy in the Congress, the Trump administration, and US foreign policy.

Moderator: **Reid Detchon**

Presenter: **Geoffrey Garin**, *President, Hart Research*

Discussants: **John Podesta**, *former White House Chief of Staff and Counselor, Presidents Obama and Clinton; Founder, Center for American Progress*
Jerry Taylor, *President, Niskanen Center*
Vic Fazio, *former Congressman; Senior Advisor, Akin Gump*

Questions, comments and discussion with ETF participants

12:15pm **Buffet lunch and presentation: “The Role of Federal Regulators as the Energy Transition Continues”**



Speaker: Richard Glick, *Commissioner, Federal Energy Regulatory Commission*

Richard Glick has served on the Commission since November 2, 2017. Previously, he was general counsel for the Democrats on the Senate Energy and Natural Resources Committee. Rich was previously vice president of government affairs for Iberdrola’s renewable energy, electric and gas utility, and natural gas storage businesses in the United States, and served as a director of government affairs for PPM Energy and director of government affairs for PacifiCorp. He served as a senior policy advisor to U.S. Energy Secretary Bill Richardson, and before that was legislative director and chief counsel to U.S. Senator Dale Bumpers of Arkansas.

1:15pm

Session 2: The transition on the ground: latest developments and implications**“What’s happening, what is working well, what do we need to fix?”****Moderator:** *Tom Baker, Partner and Managing Director, The Boston Consulting Group, USA***Panel:** *Pat Hogan, Senior Vice President of Electric Operations, Pacific Gas and Electric Company, USA**Stephen Prince, CEO, Centrica Business Solutions North America, Centrica, USA**Kathleen Barrón, Senior Vice President, Government and Regulatory Affairs and Public Policy, Exelon Corporation; Former Deputy General Counsel, FERC, USA***Group discussion: Pros and cons of light-handed vs. strong electric sector regulation****Session Objectives**

- 1) Understand the challenges and opportunities created by the transition in the US.
- 2) Discuss the influence of the regulatory compact – and the pros and cons of light-handed government oversight and the freedom to innovate vs. strong regulatory intervention.
- 3) Understand how evolutions and challenges are different by market and whether strategies employed in another global market might also be relevant in your own.

2:30pm

“How the transition differs around the world and how it doesn’t”

Brief comments on three regions:

Europe: *Suleman Alli, Director, Strategy & Regulation, UK Power Networks, UK***China:** *Felix Zhang, Group Executive Director and Venture Partner, Envision Energy, China/USA***India:** *Rajiv Mishra, Managing Director India, China Light and Power, India***Questions, comments and discussion with ETF participants**

3:00pm

Tea and coffee break

3:15pm

Session 3: Cybersecurity: what is at stake and how to address it

Cybersecurity concerns have recently taken center stage in a context of increasing digitalization of the economy and geopolitical tensions. In the case of power systems, cyber threats have since long been a preoccupation of operators. Transition to smart grids, decentralized energy generation, and proliferation of connected devices have led to exponential increases in cyber-attacks on the grid, some of them successful.

Moderator: *Gerard Reid, Co-Founder & Partner, Alexa Capital, UK*

Session Objectives

- 1) Confirm the current understanding of resilience and cybersecurity risks in the energy system, in a context of increasingly decentralized energy.
- 2) Discuss appropriate responses – managerially, technically, and in term of regulation and policy – to mitigate these risks and remedy them, whether at state, national or international level.
- 3) Learn how your cyber-protection strategies compare with those of other utilities around the globe.

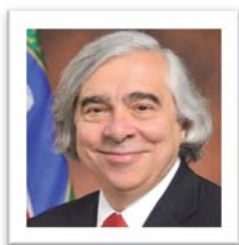
Introduction and short demonstration

- 3:45pm **Opening remarks:** *Karen Evans (Invited), Assistant Secretary for the Office of Cybersecurity, Energy Security, and Emergency Response*
- 4:00pm **Cybersecurity and the Energy Transition: a problem statement**
 How secure is the practical resilience and how high are the cybersecurity risks in our energy system? Do the risks of resilience and cyber increase or decrease in the context of increasingly decentralized energy?
Panel: *Fintan Slye, CEO, UK System Operator, National Grid, UK; former CEO, EirGrid, Ireland*
Stephen Callahan, Vice President of Global Strategy and Solutions for the Energy & Utilities Industry, IBM
Theresa Payton, President and CEO, Fortalice Solutions; CIO, President George W. Bush Administration, USA
- 4:45pm **Addressing cybersecurity**
 What should be the appropriate responses – managerially, technically, and in term of regulation and policy – to mitigate these risks and remedy them, whether at state, national or international level? How do the cyber-protection strategies compare with those of other utilities around the globe?
Panel: *Michael Coden, Managing Director, Head of Cybersecurity Practice, BCG Platinion, USA*
Nadya Bartol, Associate Director, BCG Platinion, USA
Harald Schrimpf, CEO, PSI Software AG, Germany
 In their interventions, the speakers will demonstrate how cybersecurity can become business-enabling within a utility. This can be done by creating converged governance, implementing robust cyber portfolio management, proactively addressing regulatory compliance, investing into talent acquisition and appropriate technologies, and changing the culture to view cybersecurity similarly to safety.
- 5:30pm **Questions, comments and discussion with ETF participants**
- 6:15pm Closing remarks and break for group photo
- 6:30pm Walk to Hay-Adams Hotel
 800 16th Street, NW
 Washington, DC 20006

7:00pm

Reception and Dinner sponsored by PJM Interconnection
Hay-Adams Hotel Terrace (Top Floor)

Welcome: *Andy Ott, CEO, PJM Interconnection and Co-Chair Energy Transition Forum*



Keynote Remarks: “Perspectives on the Energy Transition in the US and Globally”

Speaker: *Ernest J. Moniz, former US Secretary of Energy; Professor of Physics, MIT; President & CEO, Energy Futures Initiative*

Ernie Moniz is a nuclear physicist who served under President Obama as Secretary of Energy from 2013 to 2017. His accomplishments include leading an international initiative that placed energy science and technology innovation at the center of the global response to climate change and negotiating the historic Iran nuclear agreement alongside Secretary of State John Kerry. At MIT, he was the Founding Director of the MIT Energy Initiative (MITEI) and Director of the Laboratory for Energy and the Environment. He received a Bachelor of Science degree summa cum laude in physics from Boston College and a doctorate in theoretical physics from Stanford University.

Day 3: Friday, November 30th

8:15am

Continental breakfast and networking

*United Nations Foundation
 Board Room, 12th Floor
 1750 Pennsylvania Avenue, NW
 Washington, DC 20006*

8:45am

Welcome back and observations from the previous day

Moderator: *Reid Detchon*

9:00am

The EU long-term strategy for energy transition in accordance with the Paris agreement

Gerassimos Thomas, Deputy Director General for Energy, European Commission
 Building upon the outcomes from the previous day, Gerassimos Thomas will briefly present the EU Communication on long-term strategy for the reduction of greenhouse gas emissions (to be adopted on Wednesday, November 28, ahead of the UNFCCC Conference of the Parties (COP24) in Katowice) and engage on it with the participants.

9:30am

Session 4: The Future Role of Natural Gas

Moderator: *John Jimison*

While the energy transition has put coal and oil under pressure globally, gas has gained momentum due to abundance from shale production and relatively stable pricing. In the US, this has caused a shift in power generation from coal to gas. It has also impacted global gas markets, creating a de facto cap on prices and limiting the risk of high gas

prices. With shale gas discoveries in other parts of the world such as Argentina, China and Australia, will natural gas will become the fuel of choice for the energy transition?

Gas is preferable to coal or petroleum in terms of carbon emissions and other pollutants – yet far from carbon-free: Questions remain about reducing methane leakage and whether the CO₂ production from gas combustion – half that of coal – is tolerable if we are to avoid catastrophic climate change. And gas may rapidly become economically vulnerable to zero-emission, zero-marginal-cost renewables. Will the perspective of further regulatory restrictions on emissions, combined with the ever-decreasing cost of renewables and other technologies, limit gas in many regions to a short-term “bridge” role?

Session Objectives

- 1) Understand the impact of the natural gas boom in North America on US and global energy policy and learn the decline rates of hydro fractured gas-well production.
- 2) Discuss whether natural gas is a "transition fuel" or a long-term solution in the context of the energy transition, and what this means for future investments in new gas generation, including risks of stranded assets.

The global resource base and geopolitics of natural gas

Melanie Kenderdine, Principal, Energy Futures Initiative; former Director, Energy Policy and Systems Analysis, Counselor to Secretary Moniz, Department of Energy, USA

Dynamics and challenges in natural gas markets

Christophe Brognaux, Senior Partner and Managing Director, The Boston Consulting Group, Belgium

Questions, comments and discussion with ETF participants

How much should we count on gas to achieve the energy transition?

Mark Brownstein, Senior Vice President, Environmental Defense Fund, USA

Chad Holliday, Chairman of the Board, Royal Dutch Shell, Netherlands

Don Santa, President, Interstate Natural Gas Association; former Commissioner, FERC, USA

Pierre Germain, VP, Washington Representative Office, Total, France

11:30am	Summary of key takeaways from the workshop <i>Tom Baker, Partner, Boston Consulting Group</i>
12:00pm	“Check-out” and feedback from participants; suggestions of key topics for future ETFs
12:30pm	Informal lunch and closure